# Epidemiology of Compromised and Unfit Cattle Arriving at Auction Markets and Abattoirs in Alberta

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## ABSTRACT

Compromised and unfit cattle are a major welfare concern. The Canadian Food Inspection Agency has criteria to monitor cattle arriving in these conditions at auction markets (AM), provincial (PA) and federal abattoirs (FA). Currently there is a lack of scientific data supporting the prevalence of compromised and unfit cattle arriving at central collection points.

A pretest investigated the arrival conditions of cattle (n=2270) at central collection points in Alberta (AB). There is no standard method for assessing compromised and unfit conditions. A new assessment tool was developed to describe the severity of conditions and define compromised or unfit conditions. The inter-rater reliability weighted Kappa value between two observers was $\kappa > 0.85$, which provided confidence in the repeatability of the tool in the larger study.

Two trained observers assessed a random sample of cattle arriving to 20 locations in AB over one year. Cattle were observed at eight AM (n = 4561), 11 PA (n = 1069), and one FA (n = 4013). The effect of cattle type (beef or dairy), age (feeder/fat or mature), and seasonality (winter, summer, and fall), and mud coverage (above or below knees) was also assessed. Mature cattle had greater odds of arriving to AM (23.3; confidence interval [CI] = 13.8 to 39.3; $p < 0.01$), PA (2.8; CI= 1.7 to 4.5; $p < 0.01$) and FA (1.7; CI= 1.1 to 1.7; $p = 0.02$) in a compromised or unfit condition than feeder/fat cattle. Dairy cattle had greater odds of arriving to AM (7.5; CI = 5.3 to 10.6; $p < 0.01$) and PA (2.7; 1.4 to 5.1; $p < 0.01$) in a compromised or unfit condition than beef cattle. The odds of cattle arriving to PA in a compromised or unfit condition were 2.0 times greater in summer (CI= 1.3 to 3.0; $p<0.01$) and 1.8 times greater in fall months (CI= 1.1 to 2.7; $p < 0.01$).

Cow-level factors (age and cattle type) need to be considered when transporting cattle. Producer education regarding which cattle conditions result in poor welfare outcomes would aid in reducing unnecessary suffering of cattle being transported for sale or slaughter.

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# CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

## 1.1 Public Trust and Perception

Ethically, the Canadian cattle industry must be proactive in implementing changes outlined in the recommended Codes of Practice that include humane handling and transport (National Farm Animal Care Council, 2013). The World Organization of Animal Health defines animal welfare as an animal's ability to cope with the conditions in which it lives (World Organization for Animal Health, 2017). Animal welfare consists of a combination of scientific evidence and ethical concepts that include an animal's biological function, affective states, and living conditions (Marie, 2006).

Economically, consumers influence both the quantity and quality of beef purchased in the market (Waren et al., 2010). Recently, public concerns about animals in food production and their well-being have been evaluated by surveys, interviews, and the purchasing behaviours of consumers (Croney, 2011). These attitudes contribute to the social license to produce livestock, food security and safety, sustainability, livestock health and welfare, as well as food health and safety (Scholten et al., 2013). When attention is drawn to welfare issues surrounding livestock practices consumers often show strong emotional responses. While science-based evidence drives policy, there are some consumer perceptions that are driving the practices of farm animal care (Croney, 2011; University of Minnesota- The Food Industry Center, 2010).

In a study conducted by Heleski et al. (2004), animal science faculty members throughout the United States (US) were surveyed to determine their attitude towards animal welfare. When respondents were asked whether modes of transportation of livestock to slaughter warranted concern, their responses were equally divided into those that agreed and those that disagreed. However, more recent North American consumer attitude surveys indicate a shift in public perception (including producers, veterinarians, and scientists) regarding animal welfare in livestock (Heleski et al., 2004). This shift in perception and demands by the public regarding food animal welfare caused changes in livestock practices. As early as 2007 there was evidence that North American consumers were becoming more aware of animal production and animal welfare. Moreover, consumers with more disposable income altered their shopping behaviour by paying premiums for products differentiated based on welfare friendly practices (e.g. free-range, cage-free, grass fed, etc.) (Vanhonacker et al., 2007). Welfare friendly practices include recommended transportation practices, pain mitigation during painful procedures, housing and feeding practices, and low stress handling and transportation for all livestock. Napolitano et al. (2010) found that meat products with welfare labels helped to meet consumer demands for welfare-

friendly, on-farm management practices and influenced the welfare state of livestock. However, it is unknown whether the premium on welfare-friendly products covers the extra costs sustained by producers (Napolitano et al., 2010).

A more recent study by McKendree et al. (2014) suggested that most respondents to a welfare perception survey of on-farm practices indicated that they were least concerned about animal management at auction markets because they were unfamiliar with that segment of the beef industry. However, consumers were found to be more concerned with abattoirs due to recent undercover videos and discomfort around the issue of humane slaughter and different methods of euthanasia which is the humane termination of an animal's life, when an animal has a poor prognosis (Alberta Agriculture and Forestry, 2014). Furthermore, consumers felt that they did not have reliable information readily available regarding livestock management or slaughter practices, or their information was sourced from animal rights groups (McKendree et al., 2014). Many animal-advocacy groups such as Mercy for Animals, People for the Ethical Treatment of Animals, humane societies and other like groups receive donations to improve livestock welfare, regardless of whether their efforts benefit livestock. Legislation, voluntary bans, and activism can result in large economic impacts to agricultural industries (Prickett, 2007). Not only does this impact agriculture economically, it may also negatively change consumer perception (that may not be well educated in agricultural practices) regarding agriculture and livestock production (Li et al., 2017).

In North America, several important events have occurred that resulted in a breach of consumer trust in on-farm production practices. For example, in 2008 the largest recall of beef in US history occurred when 143,383,823 pounds of raw and frozen beef were removed from the Hallmark/Westland Meat Packing Co. in Chino, California (University of Minnesota- The Food Industry Center, 2010). This recall was a result of an undercover video obtained from a Humane Society of the United States (HSUS) investigator showing images of abattoir employees participating in acts of animal abuse. This incident was considered a federal offence resulting in a settlement of over $300 million dollars forcing the owner to close their plant indefinitely because the company had to declare bankruptcy (Nisperos, 2012). The cattle videoed were slaughtered at Hallmark/Westland; however, these cattle were unfit and should not have passed ante-mortem inspection (Nisperos, 2012; Marler Blog, 2008). Cattle must be able to stand to be considered fit enough to enter the human food supply, both ethically and with regards to food safety (University of Minnesota- The Food Industry Center, 2010). Ultimately, this event illustrated a lack of adequate surveillance and cattle handling training for abattoir employees resulting in significant

impacts to the sale of beef. This incident created a negative public perception and loss of trust in the safety of beef supplied to consumers.

Another recent example of animal abuse was reported in a Chilliwack, British Columbia (BC) dairy herd in 2014. Employees of the Chilliwack Cattle Sales dairy were videotaped inhumanely handling dairy cattle by beating and kicking, using chains and rakes to move the cattle, including downed cows. Specific employees were identified as wilfully causing unnecessary pain, suffering and injury to the cows (Global News, 2014). Unlike the Hallmark Westland incident, these animals were not destined for slaughter, but rather were milk-producing cows. After being charged with 16 counts of animal cruelty and abuse, this case resulted in a $300,000 fine to Chilliwack Cattle Sales, which also included individual fines to employees that were involved in the acts of animal abuse. These employees were then fired from Chilliwack Cattle Sales and suspended from giving care to animals for up to a year (Henderson, 2016). This negatively impacted both the local and provincial dairy industries due to negative consumer perception regarding the humane handling and care of dairy cattle, which ultimately affected consumer trust in dairy products.

Consumers are provided numerous options regarding the method of production when purchasing beef from retailers. These options may include, but are not limited to whether antibiotics, steroids or hormones were used, how the animals were housed and the method in which they were slaughtered as well as which country the products originated from (country-of-origin-labeling) (Harris, 2005; Loureiro and Umberger, 2007). Retailers have moved quickly to use naturalness and source reliability as a marketing tool and have developed contracts with producers that impose a variety of practices and conditions, from pasture to plate, that must be adhered to. The production conditions are labeled on food animal products at the retail level because the labels are ethically pleasing to consumers (Harris, 2005).

In countries with implemented food safety inspections (i.e. Canada), consumers are also concerned with quality, price, welfare and safety of food products (Wilcock et al., 2004; Loureiro and Umberger, 2007). The issues surrounding food safety largely include concerns about infectious diseases or pathogens to prevent the spread of disease from animal to animal (infectious) and animal to human (zoonoses) that may affect the quality and safety of the meat being produced and consumed (e.g. bovine spongiform encephalopathy (BSE)) (Simons et al., 2017; Loureiro and Umberger, 2007). This topic of food safety and surveillance will be discussed in more detail in Chapter 1 section *1.8 Surveillance of Cattle and Infectious Disease*.

Due to increased consumer awareness of livestock welfare from news reports such as the cases of Hallmark/Westland and Chilliwack Cattle Sales and information from animal advocacy groups, there is a demand for transparency in current practices in agriculture and more specifically within the beef and dairy industries (University of Minnesota- The Food Industry Center, 2010). Therefore, the Canadian cattle industry requires a proactive approach to quickly identify areas of welfare risk in current practices that may have a negative impact on the industry's sustainability.

### 1.2 Transportation Regulations

In accordance with the Health of Animals Regulations (HAR), cattle may not be transported for longer than 48 hours, but if they have a final destination in Canada may be transported continuously for up to 52 hours (Schwartzkopf-Genswein and Grandin, 2014). Animals that are transported must also be fit enough to withstand the duration of the trip without undue suffering. Animals should not be loaded if they can succumb to infirmity, illness, injury, fatigue, or any other cause and should not be transported if it could cause undue suffering during the journey (Health of Animals Regulations, 2017). It is the responsibility of both of the seller, buyer and transporter to ensure that the cattle are fit for transport in accordance with the HAR and the CFIA transport regulations.

One major area of welfare concern has been around the transport and sale of compromised or unfit cattle at central collection points including auction markets and provincially and federally inspected abattoirs. The safe and humane transportation of cattle carries important public and trade concerns worldwide due to the negative consequences it imposes on the Canadian beef industry's economics; animal health and welfare; and food quality and safety (Harris, 2005). Compromised cattle are defined by the CFIA as an animal *"that has reduced capacity to withstand the stress of transportation due to injury, fatigue, infirmity, poor health, distress, very young or old age, impending birth, or similar causes*" (Canadian Food Inspection Agency, 2013a). Whereas, cattle that are unfit for transportation are defined by the CFIA as *"an animal with reduced capacity to withstand transportation and where there is a high risk that transportation will lead to undue suffering such that if the animal was transported it would endure unjustified and unreasonable suffering"* (Canadian Food Inspection Agency, 2013a). According to the CFIA, the main difference between a compromised and unfit animal, is whether or not it is capable of withstanding local transportation with or without undue suffering. Should a compromised or unfit animal arrive at any central collection point, the *Meat Inspection Act* indicates that the handling of food animals in such a way that the animal might be subjected to avoidable distress and/or pain is prohibited. Furthermore, subsection 67(6), states that *"if a food animal shows*

*deviation from normal behaviour or appearance during its ante-mortem inspection, it shall be held and referred to an official veterinarian for detailed inspection and specified instructions required for proper disposal"* (Canadian Food Inspection Agency, 2016).

Under federal and provincial transport regulations, unfit cattle should not be transported unless in accordance with provincial regulations advised by a veterinarian (Canadian Food Inspection Agency, 2013a). However, compromised cattle may be transported locally to receive care, be euthanized, or be humanely slaughtered with special provisions advised by a veterinarian (Canadian Food Inspection Agency, 2013a; National Farm Animal Care Council, 2013; Alberta Agriculture and Forestry, 2014). Locally refers to the closest available abattoir for slaughter that can provide producers a humane way of culling compromised or poor doing cattle from their herd or feedlot before the issue becomes so severe that they are considered unfit. Some examples of special provisions include supplying ample bedding in the trailer or isolation of the affected animal in a separate trailer compartment.

### 1.3 Cattle Age

Cattle age can have a drastic effect on animal welfare outcomes during and after transportation. Young cattle refer to cattle that are less than 28 days old and are typically not weaned. Feeder cattle refer to calves that are weaned and less than one year of age being transported to feedlots for fattening and fat cattle refer to finished cattle that are being transported to slaughter (González et al., 2012a). Mature cattle are cattle that are greater than two years of age, and mature cattle are often interchanged with definition "cull cattle" that can be misleading as cull cattle are not always mature in age (González et al., 2012a). Cull cattle are defined as those sold for slaughter due to undesirable production traits such as poor efficiency and temperament, difficulty calving and unsatisfactory conformation or for health and welfare reasons (examples: poor udder condition, mastitis, lameness, cancer eye, and lump jaw) (Bascom and Young, 1998; Waldner et al., 2009). Typically most of these conditions that are associated with culling are also associated with the progression of age in cattle.

Feeder and fat cattle have been found to have stronger immune systems and better body condition that allow them to handle the rigors of transportation better than younger calves or mature cattle (Schwartzkopf-Genswein et al., 2016). Although feeder cattle can withstand long transportation durations with no increase in morbidity, their mortality rates were found to be greater than cull cattle (González et al., 2012a). Cull cattle were reported to have the greatest prevalence of lameness, non-ambulatory, or dead cattle on arrival to their final destination (González et al., 2012a). Goldhawk et al. (2015) used the North American Meat Institute (NAMI) compromised cattle audit system to assess the

arrival conditions of mature cattle at a federal abattoir in Canada and found that 29.4 % of mature cattle hauled were considered a serious welfare problem. Mature cull cattle had the greatest risk of becoming compromised during transportation compared to feeder/fat cattle.

## 1.4 Prevalence of Compromised Cattle in North America

Even though there are regulations in place at provincial and national levels regarding humane treatment, transport, and slaughter of cattle, there are still many unsubstantiated reports of compromised animals observed at auction markets and abattoirs (Doonan et al., 2003). Although studies have focused on the welfare of cattle during transportation and handling events, there is little scientific evidence regarding the prevalence, characterization, and disposal of compromised cattle arriving at auction markets, provincially inspected abattoirs, and federally inspected abattoirs within North America.

### 1.4.1 Prevalence of Compromised Cattle in Canada

An older study by Blakley (1979) relied upon veterinarians to assess the condition of cattle arriving at an auction market in Saskatoon, Saskatchewan weekly over a 2-year period. The objective of the study was to develop a database of diseases occurring in auction markets that often go unreported. The study found that age was strongly associated with specific disease conditions; older cattle were reported to have a greater prevalence of ringworm and eye infections (19.2 % and 4.9 %, respectively) while younger calves had a greater prevalence of congenital abnormalities (e.g. umbilical or scrotal hernias, pelvic deformities, and hermaphrodites) or gastrointestinal and navel infections (9.7 % and 5.5 %, respectively; Blakley, 1979). Blakley (1979) indicated that auction markets and abattoirs represent a different population with regards to the composition of disease prevalence in comparison to veterinary clinics, which may only represent a population of livestock that are receiving care and are mainly comprised of diseased cattle. Therefore, it was important to collect information about compromised conditions in cattle at auction markets and abattoirs to show the difference in population biases when collecting information about disease prevalence (Blakley, 1979). In this study, a veterinarian diagnosed specific illnesses or syndromes in cattle presented as compromised. Within Canada compromised and unfit cattle are assessed by CFIA or provincial meat inspectors who may or may not be veterinarians. Therefore, inspectors cannot make definitive diagnoses by visual assessment alone, which often require veterinary consultation or further laboratory testing.

A study by Warren et al. (2010) assessed the condition of fat cattle arriving at a federal abattoir in Ontario (assessed 2 to 3 days per week for 1 year) and only identified cattle that were lame (0.16 %),

non-ambulatory (0.002 %), or dead on arrival (DOA; 0.008 %). The study did not include information about other populations or other federal abattoirs within Canada (i.e. auction markets and provincially inspected abattoirs). Moreover, the study did not account for the various ages and types of cattle (cull cows, fats, and feeder cattle as well as beef versus dairy) that arrived at the abattoir, nor did it assess all other types of compromised cattle (i.e. cattle in heavy lactation, emaciated, weakness, penis injury, etc.) based on CFIA's criteria for compromised or unfit animals. A Canadian study documented the condition of 290,866 transported cattle and found the percentage of lame or compromised cattle at the time of loading, lame during transport, and non-ambulatory or DOA to be 0.005 %, 0.011 %, 0.022 %, and 0.011 %, respectively (González et al., 2012a). The same study also found that prior to transport, cattle condition was categorized as 98.6 % good, 1.3% fair, and 0.05 % poor while post-transportation, cattle were categorized as 96.3 % good, 3.5 % fair, and 0.21 % poor. The study suggests that cattle condition was more likely to decline over the journey (González et al., 2012a). However, cattle observed in that study were not assessed for compromised conditions or for the severity of compromise prior to loading. Greater than half of the cattle were transported up to 1000 km, while the remainder were transported between 1000 km and 2500 km (González et al., 2012a). It is likely that the environmental conditions can vary greatly over long distances, which may exacerbate poor welfare outcomes.

### 1.4.2 Prevalence of Compromised Cattle in the United States

Grandin (2001) conducted a transportation fitness audit for cattle arriving at 21 abattoirs within the US on two separate years (1993 and 1999). Although the total number of cattle assessed was not reported; she found that 1.5% of dairy cattle arriving to the abattoirs were non-ambulatory in 1999, which was an increase from the 1993 audit that reported only 1.1 % of dairy cattle were non-ambulatory (Grandin, 2001). Furthermore, it was suggested that weak, emaciated cows were more likely to worsen in condition during transportation and become non-ambulatory. Conversely only 0.7 % of beef cattle arrived in a non-ambulatory condition to abattoirs in 1999, which was 0.3 % lower than the non-ambulatory beef cattle observed in 1993 (Grandin, 2001). It is important to note that her audit was not designed to document other types of compromised conditions in cattle.

A cross-sectional study conducted by Van Metre et al. (2009) developed a syndromic surveillance system based on visual observations of all types of livestock arriving at an auction market in Colorado, USA over a 30-day period. The objective of the study was to develop a disease detection system to prevent the spread of infectious disease. The most commonly observed conditions in cattle were respiratory tract disease (61.9 %), thin body condition score (BCS; BCS < 2 on a 5-point scale;

23.0 %), abnormal ambulation or posture (7.10 %), and abnormalities of the eyes, ears, nose, or mouth (3.24 %) (Van Metre et al., 2009). The previous studies provide some evidence that animals with discernable abnormalities or disease that are associated with compromised conditions are still observed at auction markets.

According to the CFIA, compromised cattle may only be transported with special provisions for veterinary care or slaughter. Even though both of these studies were conducted in the US, it is important to acknowledge that auction markets may often be closer in distance to the producer shipping the compromised animal than an abattoir and therefore may be the preferred location to take such cattle.

## 1.5 Transportation and Humane Handling of Cattle in Canada

Transportation is one of the most stressful events cattle will experience within their life (Schwartzkopf-Genswein et al., 2012). Several stressors may affect the quality of transportation that cattle may experience, such as loading density, long transport durations, feed and water withdrawal, weather, trailer environment, trailer floor conditions, animal handling, driver experience, as well as animal type and age (Schwartzkopf-Genswein et al., 2016). Historically the transportation of mature cattle has been considered a serious livestock welfare issue that needs to be addressed (Goldhawk et al., 2015). The effects of cattle age on animal welfare during transportation will be discussed in Chapter 1 section *1.4.2 Cattle Age*.

### 1.5.1 Transportation Duration

In Canada, large volumes of cattle are most commonly transported by road in double deck tandem trailers pulled by tractors. Cattle may be transported for breeding, pasture grazing, live sale, feedlot for feeding, and slaughter. The consolidation of federal slaughter facilities in North America has resulted in longer transportation distances for cattle destined for slaughter across Canada and into the US (Health of Animals Regulations, 2017), which may exacerbate stress or result in poor welfare outcomes. According to González et al. (2012a) 76.0 % of fat cattle being transported went from AB across the Canada-US border, whereas only 24 % of fat cattle originating from AB traveled within or between Canadian provinces. Therefore, it is important to acknowledge that while the distance may not be long, factors such as border crossings and compliance with different axle weight regulations (this involves redistributing the weight of cattle between compartments on the trailers), can extend the length of time cattle spend on truck before they reach their final destination (González et al., 2012a; González et al., 2012b). Fat cattle were reported to be in transit for up to 45 hours (González et al., 2012a; González et

al., 2012c). Decreased livestock welfare was observed with increasing transportation durations that included an increased percentage of live weight loss (shrink), and increased arrival of lame or non-ambulatory cattle (Schwartzkopf-Genswein et al., 2016). Shrink is a result of the loss of gut fill or tissue loss in cattle during transportation due to long periods of water and feed deprivation. This is related to the fact that North American livestock trailers are not equipped to hold feed and water (Coffey et al., 2001; Schwartzkopf-Genswein et al., 2016).

### 1.5.2 Temperature and Trailer Environment

Environmental stressors may also increase the risk of poor welfare outcomes during transportation. For example, transporting and handling cattle during very hot days can increase the risk of heat stress in cattle (Schwartzkopf-Genswein et al., 2016). However, the environment within the trailer itself has several factors (i.e. space allowance, compartment, and internal trailer temperature) that may increase the risk of shrink, morbidity and mortality of cattle (Schwartzkopf-Genswein et al., 2016). Providing too much space within a trailer can cause cattle to lose balance easily as the truck turns or stops resulting in injury, whereas overcrowding within a trailer can cause cattle to become injured or trampled during loading, unloading, or high stress handling (Schwartzkopf-Genswein et al., 2016). Long trips at higher temperatures were directly associated with increased shrink (González et al., 2012c). Furthermore, cull cattle have the highest rate of shrink during transportation (5.69 %) in comparison to feeder (1.95%) and fat cattle (0.58 %) (González et al., 2012c). Thus, increasing the environmental stress during transportation resulted in greater shrink losses (González et al., 2012c).

### 1.5.3 Livestock Handling and Driver Experience

In order for producers to promote the use of low-stress handling techniques among new employees, training via other employees, veterinarians, or other third party experts in cattle handling and animal health is necessary (E. Janzen Personal Communication, 2016). Some examples of third party training include the Low Stress Cattle Handling training program through the Canadian Agricultural Safety Association (CASA) and the Canadian Livestock Transport (CLT) program (Canadian Agricultural Safety Association, 2017; Canadian Livestock Transport, 2017).

The Low-Stress Cattle Handling training program provided by CASA employs research-based information about the benefits of low stress handling. Furthermore, it describes cattle behaviour, the associated safety hazards, and appropriate use of livestock facilities (Canadian Agricultural Safety Association, 2017). The CLT program has developed training modules for livestock transporters to

ensure the safe pre-loading, loading, transit duration, in transit and arrival care of the livestock they may be transporting. This formal training tool provides information about current research, up-to-date regulations, and any disease information or recent news pertaining to livestock transportation (Canadian Livestock Transport, 2017). González et al. (2012a) found a significant relationship between drivers with less experience (less than six years of livestock hauling experience) and poor welfare outcomes (e.g. increased injury, falling, stress, and bruising) in transported cattle. Experienced drivers have greater knowledge and experience complying with transportation regulations and recommendations. González et al. (2012a) reported that cattle hauled by experienced drivers (greater than five years experience of hauling livestock) had much lower shrink than cattle hauled by inexperienced drivers (less than five years experience of hauling livestock). This further suggested that experienced drivers may have better driving skills (careful braking, cornering, shifting gears, and changing direction of travel) that could improve the balance and reduce the frequency of stumbles and falls of cattle within the trailers, therefore resulting in a better quality of transport and reducing stress that may increase shrink (González et al., 2012a). Consequently, properly trained and prepared drivers with appropriate experience and awareness can help to reduce poor welfare outcomes. The training is not limited to livestock transporters as it was also developed for anyone that handles livestock for transport such as: producers, handlers (farm staff, auction market, order buyers, and feedlots), auction market and abattoir employees, and enforcement and management personnel to be knowledgeable about all aspects of the live animal transportation process (Canadian Livestock Transport, 2017).

There is a division of responsibility between owners and cattle transporters. Therefore, it is critical to implement proper training to all personnel that are handling cattle at loading and unloading. It is also very important to acknowledge that rough handling or reckless driving may increase the risk of injury to cattle, therefore all personnel loading, unloading, or moving cattle should avoid rough handling and limit prod usage (Grandin, 2001).

### 1.6 Marketing Canadian Cattle

Alberta is home to 4.9 million beef cattle, which accounts for 41 % of the Canadian beef cowherd, 69 % of Canada's fed cattle production, and 60 % of the Canadian slaughter capacity (Alberta Cattle Feeders Association, 2016). Beef production is a multi-stage process that includes cow-calf production, backgrounding (growing) and finishing feedlots, and slaughter. Cattle are marketable at any stage within this production cycle. Major collection points of marketable cattle include auction markets and abattoirs that are both provincially and federally inspected.

Currently there are 22 auction markets, 43 provincially inspected abattoirs, and 2 federally inspected abattoirs within AB. However, cattle are still marketed outside of AB from other provinces across Canada and internationally. Canada, Mexico, and the US all contribute to this internationally integrated livestock production system in part due to the North American Free Trade Agreement (NAFTA) signed in 1994 (Mathews et al., 2006). Exportation of Canadian livestock into the US for fattening and slaughter is a common practice as the US has a larger feedlot and abattoir capacity, and beef demand than Canada providing a beneficial trade for both countries (Engebretson, 2008). Slaughter weight cattle are frequently transported to the US as Canada only has 4 federally inspected abattoirs for beef cattle in the entire country, in comparison to 43 federally inspected abattoirs in the US (Engebretson, 2008; USDA, 2017). The reduced number of federal abattoirs increases the distance and duration that cattle may have to travel as well as the number of loading and unloading events required for cattle to reach their final destination. The combination of these factors can increase the risk of poor welfare outcomes of cattle during transportation (González et al., 2012a).

Cull cattle are often collected in large numbers at auction markets by federal abattoir cattle buyers. This is to ensure that full truckloads of cattle are being transported to meet the slaughter volume demand of federal abattoirs (MacLachlan, 2001). Similarly, this is also the reasoning for the continued use of auction markets over Internet sales simply because some producers do not have enough marketable cattle to fill a transport truck. However, the online marketing of cattle works very well for those producers that do have the number of cattle required to fill multiple transport trucks at one time.

### 1.6.1 Auction Markets

Auction markets are commonly known as a central gathering point for livestock where they are sold on commission (Van Metre et al., 2009). Live cattle sold at auction markets are typically separated into two age groups: feeder and cull cattle. Feeder cattle are most commonly marketed as newly weaned calves in the fall or as yearlings in the spring and are sold to a feedlot for growing and finishing. Cull cattle are frequently sold at auction markets year-round where groups of cull cattle can be assembled for slaughter and purchased by federal abattoirs. The greatest prevalence of culling in beef cows (for any reason) was reported to occur in cattle between 5 and 10 years of age (Waldner et al., 2009). However, beef cows can remain in a herd between 3 to 8 years. The discovery of a case of BSE in 2003 caused a dramatic decrease in the market value of cull cows and market accessibility; however, their value has increased substantially over time following the 2003 event (Waldner et al., 2009).

Auction markets are frequently used as a means of culling undesirable cattle, due to a variety of reasons that may include mildly compromised conditions, which will be discussed further and defined in Chapter 1 section *1.6 The Culling Process*. As previously mentioned, federal abattoir cattle buyers often collect smaller groups of cull cattle to form one full truck load for slaughter. The sale of live cattle through a physical auction market is a traditional way of marketing cattle. However, there have been significant increases in the use of virtual sales on the Internet via video streaming through The Electronic Auction Market (TEAM) or the Direct Livestock Marketing System (DLMS) (The Electronic Auction Market, 2017; Direct Livestock Marketing System, 2017).

Anecdotally, some producers tend to be unaware of or ignore the regulations regarding transportation fitness of cattle. However, once cattle are unloaded at an auction or abattoir, they become the responsibility of that entity which must deal with the proper culling or end of life strategies for either compromised or unfit cattle. These types of cattle arriving at the auction market may be sold, refused prior to unloading, returned to the owner, or euthanized on site with or without salvage of the carcass. Auction markets are open to the public for viewing cattle, which promotes a public expectation about cattle fitness. In theory this should discourage producers from shipping cattle to auction markets in compromised and unfit conditions to avoid public scrutiny (Doonan et al., 2003). Auction markets are conflicted with the appropriate way of discouraging the transportation of compromised cattle without risking the welfare of the animal or impacting the economic viability of their business. If an auction market owner refuses cattle from a given producer, they are at risk of losing business from that producer in the future. If the animal is refused by the auction and sent back to the producer that animal may not be able to withstand transportation without undue suffering. However, if an auction market accepts a compromised animal, that animal is at risk of not being able to withstand subsequent transportation events after the sale without causing undue suffering. This is a point where economics, efficiency, and welfare have trouble converging due to lack of understanding of transportation regulations.

Small portions of cull cattle that are sold at the auction market are not immediately transported for slaughter upon sale exchange. According to Doonan et al. (2003), cull cattle may spend up to three weeks in holding before being transported for slaughter. Recently, auction market owners have reported pens of cull cattle being fed at the auction market for six to eight weeks before being transported for slaughter (E. Janzen Personal Communication, 2016). In contrast, 72 % of producers perceived that cattle stay at an auction market for less than one week before they are sent for slaughter (Li et al., 2017). Therefore, it is important for producers to select the culling option that best reduces undue suffering in

compromised cattle based on the fact that the animals condition may worsen over an extended auction market stay prior to shipping for slaughter. While this may not eliminate the long-distance transportation of cattle, it does reduce the number of times they need to be transported. In addition, Internet sales eliminate the need to transport cattle to the auction market, avoids commingling with other cattle, and additional handling. Ultimately, all of these factors may reduce the risk of cattle arriving in a compromised condition or becoming compromised while at an auction market.

### 1.6.2 Abattoirs Regular Slaughter

In Alberta, cattle may be transported to local abattoirs for slaughter. Meat from provincially inspected abattoirs may only be sold provincially, while meat from federally inspected abattoirs may be sold provincially, nationally, and internationally. Compromised cattle may be accepted for slaughter at a local provincial abattoir with special provisions. If compromised animals are slaughtered they must pass both an ante-mortem and post-mortem inspection in order for the meat to be sold or given away (Alberta Agriculture and Forestry, 2014). Furthermore, some abattoirs provide a mobile slaughter service to "shoot and bleed" an animal for salvage slaughter on farm (euthanized and exsanguinated) where the whole carcass is then transported to the plant to be eviscerated and cleaned. This is used for the private slaughter of cattle that allows the owner of the animal to consume the meat without inspection of the carcass. However, due to the number of cattle slaughtered in federal abattoirs and the rigors of a highly demanding production system, compromised cattle are discouraged from being shipped to federal facilities as they slow the production line. Legal action or a small fee may be incurred by producers if a processor has to manage an unfit animal at their facility (Doonan et al., 2003). Slaughter weight (fat) cattle and fit cull cattle are most commonly shipped to federal abattoirs in larger groups.

Producers must be able to ship compromised cattle with special provisions with approval from a veterinarian to ensure that the animal will pass ante-mortem and post-mortem inspection at the plant. Producers must be critical with loading decisions, which will be discussed in more detail in section *1.6 The Culling Process*. At the point that severely compromised or unfit cattle arrive at the abattoir, they may continue to be slaughtered, refused prior to unloading and returned to the owner, or euthanized on site with or without salvage of the carcass.

### 1.6.3 Abattoirs Salvage Slaughter

There is little information regarding the relationship between compromised conditions and carcass quality because producers invest little time and money into an animal that has a poor prognosis

(Amadou et al., 2013). Amadou et al. (2013) reported that cull cows represented 15 to 30 % of a cow-calf herd's annual revenue in the US, indicating that producers tend to give cull cow marketing less attention as far as herd health management than they give to feeding and marketing steers, heifers, and reproductive cows.

Sometimes compromised and unfit cattle cannot withstand transportation without undue suffering or a veterinarian recommends an on-site slaughter that eliminates the transportation of an animal that is still safe for human consumption. A classic example of this is an animal with a broken or severely injured limb that results in severe lameness. Therefore, it has become a common practice by ranch and feedlot producers to euthanize or sell (rail) cattle for humane or economic reasons prior to the animals intended market weight to eliminate welfare issues (Alberta Agriculture and Forestry, 2014). Producers are able to slaughter these cattle in order to salvage the carcass on site, or at a licensed provincial abattoir.

### 1.7 The Culling Process

There has been a drastic shift in the way producers cull cattle after the discovery of a case of BSE in Canada in 2003. Waldner et al. (2009) reported that in pre-BSE years (2001-2002), the causes of death on farm differed from conditions reported in cull beef cattle at the abattoir. Common causes of death on farm include acute conditions such as bloat, or any condition that prohibits carcass salvage value such as hardware disease or infectious diseases (i.e. Johne's, BSE, and Brucellosis) (Alberta Agriculture and Forestry, 2016). Common health conditions observed ante-mortem in cull beef cows at slaughter were conditions such as lameness, cancer eye, and lump jaw (Waldner et al., 2009). There were reported differences in cattle conditions on farm in comparison to what was observed at slaughter because the culling process was more intensive on farm before BSE due to the fact that cattle had very low economic value with the onset of BSE. At the time of the BSE outbreak cattle were more likely to be euthanized on farm than transported for sale because they had relatively little value (Waldner et al., 2009). Thus, the culling strategy for compromised beef cattle includes euthanizing on farm, or selling for slaughter. Cattle currently have high economic value (rail (eviscerated hanging carcass) prices are currently between $249.00-265.50 per 100lb weight) (CanFax, 2017). Therefore, even compromised cattle are salvageable for rail carcass prices.

A recent study showed that the top five factors producers considered when transporting cattle for sale included: an animal's soundness/mobility, health/disease status, veterinarian recommendation, market price, and age (Li et al., 2017). Amongst those criteria, it is important for producers to manage

culling cows from herds in advance of becoming weak or emaciated or before compromised conditions worsen (Grandin, 2001). Weak or emaciated cattle are still arriving at auction markets, when they should be slaughtered according to CFIA (Canadian Food Inspection Agency, 2013a).

In addition to the humane termination of an animals life, euthanasia may also be used to ensure human safety, or as a regulatory requirement to aid in disease control. A recent study reported that the top five factors that producers considered when euthanizing cattle on farm (listed in decreasing order of importance) included: the animal's quality of life, severe injury, decreased likelihood of recovery, animal's disease status, and animal's fitness for transport (Li et al., 2017). Ultimately, an animal should be rendered unconscious with minimal pain or distress prior to the termination of all vital life functions (National Farm Animal Care Council, 2013).

Similar to beef cattle, dairy cattle are culled due to lack of successful breeding or calving problems, low production, unsatisfactory type for replacement back into the herd, mastitis, teat injury, old age, poor workability and other reasons (e.g.: lameness, bloat, etc.) (Batra et al., 1970; Sol et al., 1984). Cull dairy cattle include those animals that have been euthanized on farm, sold for beef, or sold to another dairy. Unlike beef cattle, cull dairy cows are often circulated back into the dairy production system (Batra et al., 1970). Dairy cattle have an average life productivity of 3.5 years, which means most dairy cattle are culled between 5 and 6.3 years of age. In addition, the timing of culling is dependent on several factors including producing milk, slaughter value, and age (Sol et al., 1984). Sol et al. (1984) estimated the annual culling rate of dairy cows to be between 5-50 % per farm. Thus, the majority of dairy animals going to slaughter are older spent cows, which is approximately 3 times greater than young dairy cattle going to slaughter.

### 1.8 Culling Strategies for Compromised and Unfit Cattle

The transportation of compromised or unfit cattle can occur as a conscious decision by the owner, but can also occur unknowingly when a seemingly healthy animal is loaded onto a trailer and arrives to its final destination in a compromised or unfit condition. Some compromised cattle cannot handle the stress associated with transportation even if for a short distance or period of time as the conditions and associated pain or undue suffering is entirely dependent on the animal's condition. However, it is often difficult for producers to determine whether or not these cattle can withstand local transportation (Doonan et al., 2003). From a regulatory point of view one might argue that transporting compromised cattle is a breach of farm animal welfare. From a producer's point of view, euthanizing a compromised animal on farm may be considered wasteful if the animal is in otherwise good body

condition. Disposal of an animal on farm may include rendering or burial decomposition without the option of carcass salvage (E. Janzen Personal Communucation, 2016).

Producers often transport compromised or unfit cattle to auction markets simply because they have no alternative way of disposing animals due to provincial restrictions, lack of inspectors, or the abattoir is farther away from where the animal has to be transported than the auction market (Doonan et al., 2003). In a recent survey 72 % of producers indicated that the nearest abattoir was 1 to 2 hours away (Li et al., 2017). This results in auction markets becoming the more convenient option for producers to dispose of compromised cattle, as auction market locations are more locally distributed than abattoirs.

The Canadian Codes of Practice provide guidelines for handling compromised cattle and defining which compromised conditions may or may not be permitted for transportation based on the HAR. According to the recommended transportation practices of the National Farm Animal Care Council (NFACC; Section 5 (2013), cattle must be in good health and physical condition to withstand transport. If personnel are unsure of the animal's fitness for transport they are advised to consult a veterinarian. While NFACC's recommended practices fall within the legislation of HAR (48) (refer to Section 2), they give guidelines to producers about how to handle cattle and make transport decisions, specifically (National Farm Animal Care Council, 2013).

A major problem associated with compromised and unfit cattle is lack of producer knowledge, training, and understanding of the severity of conditions that are appropriate for transport. Furthermore, there is a lack of communication and understanding between producers, inspectors, and processors or auction market owners about what is acceptable to ship due to inconsistency in opinions about what cattle are considered fit for transportation. The lack of consistency (in defining compromised and unfit) of CFIA inspectors will be discussed in greater detail in Chapter 2 of this thesis. Not only do animals in compromised or unfit conditions degrade the marketing and welfare of livestock, but they also pose a large economic burden on the producer, the transporter, and processors (Doonan et al., 2003).

### 1.9 Surveillance of Cattle and Infectious Disease

The aim of disease surveillance of cattle shipped to auction markets and abattoirs is to document trends in clinical signs, compromised conditions, and abnormalities that merit further investigation as part of preventing disease outbreaks (Van Metre et al., 2009). The Canadian agri-food industry and their stakeholders (e.g. industry supporters, retailers, processors, and producers) have supported surveillance of food safety at provincial and federal government levels through traceability and testing so that animals of concern can be identified quickly (Rajic et al., 2007). Cattle should be assessed on arrival to

an auction market or federal abattoir by a brand inspector (Livestock Identification Services Ltd. (LIS)) and a CFIA inspector. Upon arrival to a provincial abattoir cattle are inspected ante-mortem by a brand inspector and a provincial meat inspector (Alberta Meat Inspection Branch; AMIB). The brand inspector verifies that the cattle belong to the producer selling the animals by checking the registered brand on their hide, with the goal of identifying stray or stolen stock. However, the responsibility of AMIB is to ensure all livestock and their meat is fit for human consumption, that the slaughter facilities comply with food safety regulations, and that all animal slaughter is humane (Alberta Agriculture and Forestry, 2016). Meat inspectors also collect samples as part of provincial and federal surveillance and food safety programs such as testing for infectious diseases of on-going concern such as Brucellosis, Chronic Wasting Disease, BSE, and *Echinococcus granulosus* (Alberta Agriculture and Forestry, 2016). The role of the CFIA is to monitor cattle ante- and post-mortem at both auction markets and abattoirs to evaluate and provide surveillance regarding the current infectious disease status and prevention of outbreaks within cattle at both auction markets and abattoirs (Canadian Food Inspection Agency, 2013a).

An example of where Canadian disease surveillance was successful in rapidly identifying a food safety and animal welfare issue was in the case of the BSE outbreak in May of 2003. This outbreak caused a substantial economic hardship to Canadian beef producers as the US and all other trading countries cut off all trade of Canadian beef (Mathews et al., 2006). This illustrates the importance of the inspection of cattle sent for slaughter at both the ante-mortem and post-mortem levels. Certain infectious diseases may be captured in a compromised animal depending on the severity. While using strictly visual evaluation, certain clinical signs can be indicative of certain diseases and can prevent disease outbreaks. For example, cattle with nervous or aggressive behaviour, abnormal posture, uncoordinated movement, difficulty standing, or non-ambulatory cattle that are over thirty months (OTM) of age may have brain tissues submitted for further BSE diagnostic testing (Alberta Agriculture and Forestry, 2015a). Assessing cattle in a compromised condition arriving at auction markets and abattoirs also serves as a useful tool in determining the burden of disease and preventing disease outbreaks within the Canadian beef cattle population.

### 1.10 Auditing Beef Cattle Welfare

All provincial and federal abattoirs perform in-house inspections of their facilities regularly to facilitate any changes in protocol required to optimize animal welfare and human safety. An example of an auditing system used frequently within the beef cattle sector is the Professional Animal Auditor Certification Organization (PAACO). PAACO is a certification body that provides incentive to monitor

livestock welfare through different audit systems that have been developed by industry stakeholders at the producer level and at the processing level at abattoirs in both North and South America (Professional Animal Auditor Certification, 2016).

There are several other auditing programs used at both the production and processing levels. These programs include the North American Meat Institute's (NAMI) Animal Handling Guidelines and Audit Guide, the National Cattlemen's Beef Association's Beef Quality Assurance (USA-BQA) Program, and a newly developed Canadian Feedlot Animal Care Assessment Program, and Verified Beef programs. Each of these programs aims to examine the care, handling, and ethical treatment of the animal from the producer to the processor in an objective and consistent manner (National Cattle Feeders Association, 2017). All Canadian audits and recommended practices are in accordance with the HAR (Health of Animals Regulations, 2017). Recommended practices are recommendations put forward for producers based in part on scientific evidence.

Through the use of audit systems, third party representatives can critically look at where the problems of compromised cattle are arising. Furthermore, to aid in the reduction of undue suffering in cattle, proactive approaches must be taken by making proper culling and disposal decisions.

### 1.11 Research Objectives

The objectives of this thesis were to:

1) Develop methodology for categorizing various compromised conditions;
2) Assess the number of cattle arriving at AB auction markets and abattoirs in a compromised and unfit condition and characterize which compromised conditions are most prevalent;
3) Document marketing endpoints (sold in sale, returned to owner, refused, transported to nearest abattoir for regular slaughter, regular slaughter, on-site euthanasia with salvage, and on site euthanasia with no salvage) of compromised and unfit cattle arriving at auction markets and abattoirs.
4) Determine the relationship between compromised/unfit status and cattle age, cattle type, sex, mud condition and seasonality.

## Chapter 2. Development of Methodology for Categorizing Various Compromised and Unfit Conditions at Auctions and Abattoirs in Alberta

*Chapter 2 describes a pilot study in which a new assessment tool was developed to aid Canadian cattle industries in identifying compromised and unfit cattle consistently over time by two or more evaluators. The new tool was based on the current criteria used to define fitness for transport developed by the CFIA. To improve observer repeatability (from the CFIA criteria) scoring systems were developed that took into account condition severity as well as the occurrence of multiple conditions within the same animal. Criteria were removed to eliminate the need for handling the cattle and diagnostic testing and to ensure the tool could be used by non-veterinary observers. The inter-rater reliability Kappa statistic for the new tool was $r > 0.85$ which provided confidence that it could be used to collect data for the main study. In the main study, the overall prevalence of cattle arriving in these conditions was low (ranging from 0.1 % to 18.0 % in all location types) suggesting that the regulations are being followed to a certain degree. Further reducing this prevalence will entail providing industry stakeholders with simple and clear assessment methods and disposal alternatives.*



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**Author contributions:** Heuston and Deither performed site visits, observations, and data analysis. Heuston, Deither, Greter, Moya, Windeyer, Janzen, and Schwartzkopf-Genswein assisted in the development of the new assessment tool and experimental design.

# CHAPTER 2: DEVELOPMENT OF METHODOLOGY FOR CATEGORIZING VARIOUS COMPROMISED AND UNFIT CONDITIONS AT AUCTIONS AND ABATTOIRS IN ALBERTA

## 2.1 Introduction

Marketing live animals for the purpose of resale or slaughter is an essential part of both beef and dairy production cycles (González et al., 2012b). Major collection points for marketing cattle include auction markets and abattoirs. With the exception of some internet sales, the vast majority of cattle in North America must be transported by road to these collection points to be marketed (González et al., 2012b).

Transportation is one of the most stressful events cattle will experience within their lifetime (Schwartzkopf-Genswein et al., 2012); as a result there is much public concern regarding animal welfare during transport (Harris, 2005). Consequently, transport regulations have recently been implemented in Canada to better define fitness for travel and provide guidelines to reduce negative welfare outcomes (Health of Animals Regulations, 2017). Under these regulations, cattle are defined as compromised when they have reduced capacity to withstand the stress of transportation due to illness etc., or unfit if they are at high risk of undue suffering during transportation (Canadian Food Inspection Agency, 2013a). Compromised animals may only be transported with special provisions for care, euthanasia or slaughter, while unfit cattle should not be transported except for veterinary treatment (Canadian Food Inspection Agency, 2013a). Although the regulations provide some criteria to aid in determining whether an animal is compromised or unfit; at this time there is no standard method of assessing the fitness of cattle for transportation in North America (National Farm Animal Care Council, 2013). In addition, there is a lack of scientific information regarding the prevalence of compromised and unfit cattle or which specific conditions related to them are most commonly observed at major collection points.

Consequently, the objectives of this study were to develop an assessment tool for determining transport fitness of cattle and to use the tool to determine observer agreement, prevalence of compromised and unfit cattle, as well as the identification of the most predominant conditions and marketing endpoints of compromised and unfit cattle arriving at a subset of auctions and abattoirs within Alberta.

## 2.2 Materials and Methods

### 2.2.1 Pretest: Development and repeatability testing of the assessment tool

Although the study was only observational in nature, approval was still obtained from the Animal Care and Use Committee of the Agriculture and Agri-Food Canada Lethbridge Research Centre according to the guidelines established by the Canadian Council on Animal Care (ACC 1634; National Farm Animal Care Council, 2013).

An internal research team consisting of four researchers created an initial list of animal conditions/indicators that could be used to identify compromised and unfit cattle at auctions and abattoirs. The list of conditions included the current CFIA criteria outlined in the regulations as well as those added by the research team as shown in *Appendix A* and *B* (Health of Animals Regulations, 2017).

Prior to conducting the pretest, the previously mentioned list of conditions were presented to an expert panel of nine people formed to further assist with the development of a practical and relevant set of animal conditions that could be incorporated into an assessment tool used for collecting information in the field. The panel included experts from the University of Calgary, Faculty of Veterinary Medicine, Alberta Beef Producers, Beef Cattle Research Council, Alberta Cattle Feeders Association, Alberta Auction Markets Association, Alberta Meat Inspection Branch, Agriculture and Forestry Livestock Welfare, Alberta Milk, and the Canadian Food Inspection Agency. In addition to the expert panel, study participants (Alberta auction market owners, and managers of provincial and federal abattoirs) were consulted to provide additional factors that needed to be considered when conducting observations at a given site. Following consultation with the expert panel, the research team finalized which indicators of compromise and unfit conditions would be included in the assessment tool as well as other basic information on the date, location, type of animal, and marketing end points (sold, returned to owner, refused, transported to nearest abattoir for regular slaughter, regular slaughter, on-site euthanasia with salvage, and on site euthanasia with no salvage) for the animal based on consensus of the group.

The tool included three main sections: general information, compromised conditions, and the marketing end points of cattle arriving at central collection points (Figures 2-1 and 2-2). The information collected within each section will be described separately with justification for retaining, removing or adding criteria based on the finalized tool to be used in the pretest.

### 2.2.2 Pretest: Site Selection

Prior to conducting the pretest, auction and abattoir facilities were selected on the basis of their willingness to participate, as well as their annual sale/slaughter volumes and geographic location. For the purposes of having a representative sample of cattle across the province, all participating auctions and abattoirs operating within Alberta were stratified by throughput volume (low and high volume for auctions and low, medium, and high volume for abattoirs) and geographic location were Airdrie, AB was used as the boundary between north and south locations.

Auction market size was determined based on the estimated annual sale throughput volumes of all 22 auction markets operating in within AB at the time of the study (The Alberta Auction Markets Association, 2017). Using the median number of cattle sold in auction markets annually; high and low volume auction markets were defined as having sold ≥ 65,000 and < 65,000 cattle annually, respectively. The participants used in the study included four auction market groups (strata): small northern auction markets; large northern auction markets; small southern auction markets; and large southern auction markets where two sites were randomly selected for assessment within each strata to yield a total of eight auction markets (8 of 22; 36 %).

Provincial abattoir size was determined based on annual inspected slaughter volumes of 43 provincial abattoirs in AB obtained from the Alberta Meat Inspection Branch (AMIB) (Alberta Agriculture and Forestry, 2015b). Low volume auctions were defined by AMIB as slaughtering < 275 cattle annually, while medium and high volume abattoirs had an annual slaughter between 276-543 and > 543 cattle, respectively. The final group of participants consisted of 11 provincial abattoirs (11 of 43; 26 %); four low, three medium, and four high slaughter volume abattoirs.

At the time of the participant selection, there were three federal abattoirs operating within the province of AB. Only two of the federal abattoirs received cattle at a regular interval and were able to meet data collection requirements. One federal abattoir (1 of 3; 33 %) having

slaughter volumes estimated at approximately 1,000,000 head of cattle annually volunteered to take part in the study.

### 2.2.3 Pretest: Data collection

The pretest was conducted over a three-month period between January and March of 2016 by two researchers (from the research team) familiar with cattle and identifying common cattle ailments and injuries in a production setting. A total of 2270 cattle were randomly selected over 20 sites that agreed to participate in the study: eight auction markets (847 cattle), eleven provincial abattoirs (89 cattle) and one federal abattoir (1334 cattle). The number of animals included in the pretest was based on how many locations could be visited by the observers during the 3-month period assigned for this purpose, rather than using a power calculation in the pretest. Each facility was visited once by each researcher where they conducted their assessments using the tool which is described in detail in the following sections.

As the majority of facility managers did not permit the researchers to enter pens containing cattle, observations were made at ground level outside of the pens or from a catwalk that overlooked the pens depending on each site manager's preference and facilities. Consequently, all researcher assessments were only observational in nature with no physical components such as obtaining body temperature or palpating for body condition score (BCS). All cattle were assessed within randomly selected pens and for a minimum of 30 seconds per animal record relevant information in the assessment tool and also observed during ambulation to assess their gait. Ambulation was also assessed at unloading or when staff was moving the animals to a holding pen. After each site visit, specific conditions were excluded from the list identified earlier and the remaining conditions were used in the final assessment tool to be employed in the main study. Conditions were excluded on the basis of specific conditions requiring a clinical veterinary assessment, further laboratory testing to confirm diagnosis, or the fact that a condition was not observed frequently enough during the study. Inter-rater reliability (IRR) was calculated between the two researchers at the end of each month for all scoring systems within the assessment tool including BCS, mobility, respiratory, mud, and CC score.

#### 2.2.3.1 General Information

This section of the assessment tool included recording the type of facility (auction, provincial or federal abattoir), cattle type (beef or dairy breed), sex (female, steer, or bull), age

(neonatal calves (< 28 d of age) with the presence of umbilical cord tissues; feeder, growing or finishing feedlot cattle or yearlings off pasture, or mature; older than finished weight cattle), and mud score (four point scale (from Mader and Colgan, 2007)). In addition the animal id (numbered sequence of animals assessed within a single pen) and the pen number the animal was housed were recorded.

Due to the fact that visually assessing cattle age is difficult it was decided that the category (young (< 28 days of age), feeder/fat or mature) in which the cattle were marketed could be used as a proxy for animal age. The amount of mud or tag present on an animal has been shown to correspond directly with poor welfare outcomes in cattle such as being non-ambulatory or sick cattle (Mader and Colgan, 2007) and therefore was added to the assessment tool. A mud/tag score of one was used to define cattle that were clean with some mud below the knees, a score of two indicated some mud on the legs above the knees with the belly and sides clean; a score of three if the belly was covered in mud and four if the belly and sides were covered in mud (Mader and Colgan, 2007).

Information in this section was collected to document associations between these factors and compromised and unfit animals as well as identifying the most common types of compromise and unfit conditions, mortality and how the cattle were ultimately managed (marketing endpoints) at each location type.

#### 2.2.3.2 Compromised and Unfit Conditions

This section assessed specific conditions that could negatively impact an animal's fitness for transport and which were recorded under the following categories: Nutrition, Depression/Attitude, Respiratory Issues, Indicators of Pain, Mobility Issues, Udder Condition, Eye Health Conditions, Injuries and Integuments, Reproductive Health Conditions, and finally Abnormal Behaviour (Figure 2-1 and 2-2). The "Other" category documented any additional conditions that were relevant to assessing an animal's fitness for travel. The conditions assessed within each category are described below and were considered mutually exclusive such that more than one condition could be documented in a single animal. Figure 2-1 was the main data collection sheet in which all animals assessed during a site visit were recorded. Figure 2-2 was a more detailed sheet that was referred to in Figure 2-1 for cattle that had multiple conditions or various indicators of compromised or unfit conditions that required a more in depth assessment.

#### 2.2.3.3 Nutrition

The criteria used by the CFIA to assess nutrition related issues include the presence of emaciation, dehydration, weakness, or bloat. The definition of emaciation used by the CFIA is a BCS of < 2 on a five-point scale with the added criteria that cattle must show weakness (Canadian Food Inspection Agency, 2013b). The CFIA regulations do not identify a specific body condition score (BCS) for defining emaciation. Consequently, the five-point BCS previously described by Kellog (2017) where a score of one indicated an emaciated animal and a score of five indicated an obese animal. The current assessment tool defined emaciated as an animal having a BCS of ≤ 1.5. Cattle were considered compromised if they had a BCS of 1.5 and unfit if they had a score of ≤ 1. It should be noted that the BCS used in this study was based solely on visual observation and did not include palpation to assess fat cover. CFIA's dehydration criterion was difficult to observe in the field and therefore was not included in the current assessment tool. However, weakness and bloat were easily identifiable by using the attitude/depression score and therefore was included in the final assessment tool.

#### 2.2.3.4 Depression/Attitude and Respiratory Issues

Compromised conditions involving a respiratory issue are currently defined by the CFIA as laboured breathing and if accompanied by a fever the animal would be considered unfit for transport (Canadian Food Inspection Agency, 2013a). As the researchers in this study were unable to determine if an animal was febrile in an auction/abattoir setting, the assessment criterion was altered to include a modified five-point scale and a four-point depression scale (Depression Attitude Respiratory Temperature; DART) previously described by (Dewell, 2013) that was modified to include a fifth point. The original respiratory scoring system was designed to determine the onset of infectious respiratory disease in the feedlot setting. However, for the purposes of this study, modifications were made to include non-infectious causes of laboured breathing such as heat stress. Therefore, a respiratory score of zero indicated cattle with clear eyes, clean nose with no discharge and normal breathing. A respiratory score of one indicated mild respiratory issues with serous discharge from eyes and/or nose, with a slight cough. Both original zero and one scores were retained in the assessment tool however, a respiratory score two was altered to include drooling in addition to the defined moderate respiratory issues with mucopurulent discharge, cough and increased respiratory rate (Dewell, 2013). Drooling from the mouth was added as it has been previously reported as an indicator of heat stress (Brown-Brandl

et al., 2006). Dewell's (2013) respiratory score three indicated severe respiratory issues with excessive mucopurulent discharge, harsh cough, and open mouth breathing. This score was also modified to include the presence of an extended neck and drooling from the mouth, as these two conditions have also been reported to be indicators of heat stress (Brown-Brandl et al., 2006). An additional score (four) was included for the purposes of capturing the most severe cases of respiratory issues which included all previous indicators with the addition of belly breathing, relucance to move, lying down, and having a protruding toungue as indicated in other panting scores in the literature (Brown-Brandl et al., 2006). Cattle were considered compromised if they had a respiratory score of three and unfit if they had a score of four.

The depression/attitude scale used for the assessment tool remained the same as that described by Dewell (2013). A score of zero was used to define cattle that appeared normal, bright, alert, and willingly moved away from the observer. A score of one defined cattle that appeared slightly depressed, otherwise normal and continued to willingly move away from the observer. A score of two defined cattle that stood with heads down, ears drooped or floppy, lacking abdominal fill, and where reluctant to move away from the observer and a score of three indicated cattle that stood with heads down, had noticeable gauntness in the abdomen, and were extremely reluctant to move away from the observer if at all (Dewell, 2013). Cattle were considered compromised if they had a depression/attitude score of two and unfit if they had a depression score of three. In addition to CFIA's laboured breathing criteria, other characteristics of respiratory issues  such as nasal and oral discharge (blood, serous, mucopurulent, or purulent discharge), elevated respiratory rate, panting, elbow abduction, and neck extension and wheezing (Dewell, 2013; Canadian Food Inspection Agency, 2013a) were also documented.

#### 2.2.3.5 Mobility Issues

According to the CFIA regulations (2013b) an animal is considered compromised if it has imperfect locomotion, a limb amputation, or congenital limb deformities. Imperfect locomotion was considered too vague a term to use in an assessment tool, as cattle can have varying degrees of lameness. Cattle with slight imperfect locomotion (i.e. mobility score of one or two according to the scoring system described by the North American Meat Institute (NAMI)) (North American Meat Insitute, 2016) may still be mobile enough to be transported normally. However, what is lacking in the CFIA definition is the degree of lameness required for an animal to be considered either compromised or unfit. Furthermore, regulations indicate that cattle are unfit if they are

unable to stand without assistance or to move without being dragged or carried, unable to walk after splitting, suffer severe pain when walking, require hobbles to stand or to prevent further injury, have a ruptured pre-pubic tendon, or fractured limb, pelvis or other factures that may cause undue suffering and pain to the animal during loading, transport, and unloading (Canadian Food Inspection Agency, 2013a). However, a ruptured tendon or fractured limb can usually only be diagnosed through clinical examination by a veterinarian and therefore it is not practical for producers, truck drivers, etc. to assess these conditions. In addition, not all fractures are easily identifiable when observing cattle in holding pens. Within the assessment tool, animals were only identified as having a fractured limb if they had an open fracture to ensure an accurate assessment. Consequently, the CFIA criteria were not used and instead, lameness was assessed using the five-point mobility scale modified from the NAMI scoring system (North American Meat Insitute, 2016). A mobility score of 1 indicated that cattle walked normally with no apparent lameness or changes in gait. A mobility score of two indicated mild lameness such that cattle were able to keep up with their group, but exhibited one or more of the following: stiffness, shortness of stride, or slight limp. A mobility score of three indicated moderate lameness such that cattle would lag behind their group and exhibit one or more of the following: obvious stiffness, difficulty taking steps, obvious limp, or exhibiting obvious discomfort. Mobility score of four indicated severe lameness such that cattle were non-weight bearing on affected limb(s), and extremely reluctant to move even when encouraged by a handler. The NAMI system records non-ambulatory animals, but does not assign them a score (North American Meat Insitute, 2016), therefore a mobility score of five was added to indicate non-ambulatory cattle that cannot rise without assistance or a standing animal that cannot move even when encouraged by a handler. In the current assessment tool the potential causes of lameness or modified gait included: abnormal hooves (abnormally long straight hooves, scissor hooves, or corkscrew hooves), ataxia, muscle atrophy, amputation, missing hooves/limbs, non-weight bearing, and the use of hobbles to prevent kicking or splitting (Canadian Food Inspection Agency, 2013a). Assessing any anomalies such as deformities and amputations will be described in more detail in the Injuries and Integuments section. Cattle were considered compromised if they had a mobility score of three and unfit if they had a mobility score of four with the presence of instability or a mobility score of five.

#### 2.2.3.6 Udder Condition

Under the CFIA criteria cattle are considered unfit if they are in heavy lactation and would not be milked within 12 hours of being transported, however, udder condition was not mentioned or assessed (Canadian Food Inspection Agency, 2013a). Difficulty in determining when an animal was last milked or anticipating when an animal would be milked within 12 hours of transport lead to the removal of this criteria within the new assessment tool. Instead, an udder condition scale previously described by Goldhawk et al. (2015) to assess the condition of cull cows arriving at an abattoir was added. Briefly, udder condition was defined as "poor" when the udder descended well below the hock, or if the udder was distended enough to push against the hind legs causing difficulty in movement (ruptured suspensory ligament), causing obvious pain/distress to the cow. Udder condition was defined as "lactating" when the udder was engorged with or without the presence of milk dripping from teats and "torn" when the udder was torn or had ruptured teats (Goldhawk et al., 2015). In the present assessment tool, cattle were considered unfit if they were in heavy lactation, and cattle with poor udder conditions were further assessed under Injuries and Integuments to determine fitness for transport.

#### 2.2.3.7 Eye Health Conditions

According to the CFIA's assessment criteria, an animal with impeded eye health is considered compromised if there is partial or total blindness in both eyes or an ocular mass where the eye is no longer intact (Canadian Food Inspection Agency, 2013b). An animal is considered unfit if the lesion extends beyond the orbit and involves other structures or the eye, is obliterated and the lesion resembles a highly vascularized, friable, necrotic open wound (stage two or three ocular squamous cell carcinoma (OSCC)) using the OSCC Scoring system developed by the CFIA (2013b). However, one limitation of the previous criteria is that the determination of what eye structures are affected by a tumor requires a thorough post-mortem examination and laboratory testing for a definitive diagnosis. In addition, the eye assessment described by the CFIA is not practical for use in assessment by non-veterinary evaluators because it requires expert knowledge. Eye health conditions incorporated into the final assessment tool included ocular masses, opaqueness, redness, tearing, discharge, missing eyes, and blindness or behaviours that were typically associated with blindness (e.g. inability to navigate an environment without running into fences or other animals). Cattle were considered

compromised if cattle exhibited signs of blindness and had significant lesions where the eye was no longer visible.

#### 2.2.3.8 Injuries and Integuments

The following conditions were included in CFIA's compromised condition criteria: severe open wound/lacerations, incomplete healing after a surgical procedure (dehorning, castration, enucleation, etc.), acute frostbite, abscess, and lump jaw (Canadian Food Inspection Agency, 2013a). All of the listed conditions with the exception of lump jaws, abscesses and frostbite could be reliably assessed in a field setting so they were retained in the new assessment tool. Lump jaws and abscesses were removed due to the fact that there are several different causes for a mass to occur on an animal's jaw (i.e. bottle jaw, abscess, or lump jaw) or in different body locations (i.e. head, limbs, and body) (Smith, 2016). Similarly, acute frostbite cannot be reliably assessed under field conditions and was also not included in the assessment tool.

In addition, all open wounds or lumps present on the animal were documented according to size (small, medium, and large), location (head, limb, body, or multiple), and whether it impaired normal movement of the animal. Furthermore, the number of wounds or lumps, and descriptions about whether the wound was open or closed, and the type and amount of discharge coming from the wound (blood, serous, or purulent discharge) were also added to the assessment.

Closed wound conditions included in the CFIA regulations (Canadian Food Inspection Agency, 2013b) consisted of swollen joints, lump jaws, and abscesses. These criteria were modified in the assessment tool to be described as lumps and their location on the body identified. This was done to eliminate the chance of misdiagnosis as most injuries or lumps observed during the pretest had unknown origins and would have required further examination to confirm their cause. For example, a large lump on an animal's mandible would be recorded as such instead of speculating whether it was bottle jaw or lumpy jaw because this could not have been determined without doing a more thorough assessment.

Open wound assessment was documented as previously described for closed wound assessment. This category included bone fractures, broken horn(s), and incomplete healing after a surgical procedure (e.g. castration, rumen cannulation, eye enucleation, etc.). When unhealed surgical wounds were observed, the assessment included a written description of the affected

area and the suspected procedure. Ultimately cattle having severe injuries, open wound lacerations or incomplete healing after a procedure were considered compromised. The exception to this was any suspected bone fractures where an animal was considered unfit for transportation.

#### 2.2.3.9 Reproductive Health Conditions

Reproductive conditions identified in the CFIA regulations for the identification of compromised cattle includes: acute or unhealed penis injuries, rectal or vaginal prolapse, and cattle that have given birth within 48 hours preceding transportation. Furthermore, cattle are considered unfit if they have a uterine prolapse, or if calving is imminent (Canadian Food Inspection Agency, 2013a). The conditions retained in the new assessment tool included penis injuries, cows that were imminently calving (with the presence of placental membranes, feet, or have a newborn calf present), and vaginal, rectal, and uterine prolapses. For assessing penis injuries and prolapses, a similar protocol to that described in the Injuries and Integuments section was used to describe discharge, size, and description of the area of concern. The same criteria and conditions used by CFIA for defining compromised and unfit reproductive conditions were used in the current assessment tool.

#### 2.2.3.10 Indicators of Pain, Abnormal Behaviour, and Other Conditions

The CFIA regulations currently do not include descriptors of pain or abnormal behaviour as part of their fitness for travel criteria (Canadian Food Inspection Agency, 2013a). Indicators of pain were added to the new assessment tool and included: belly kicking, weight shifting, foot stamping, teeth grinding, excessive tail swishing, and vocalization which have been previously reported as behaviours associated with pain (Gleerup, 2015). Behaviours such as aggression, flightiness, or unwillingness to move were also added to the assessment tool because they are also useful indicators of neurological symptoms, pain, or distress (Iulini et al., 2012). Signs of pain were not used to score an animal's overall compromised or unfit condition alone in the new assessment tool (Compromised Condition (CC) Scale section), but were used to describe the overall condition of the animal (fitness).

The CFIA regulations include an "Alternative" category used to document conditions such as buller syndrome, hernias that impede movement, or if the animal is in shock or dying. Cattle are considered unfit if they are weak, unsteady, exhausted, or have a suspected or confirmed nervous system disorder (Canadian Food Inspection Agency, 2013b). The "Other"

category within the new assessment tool captured similar conditions and included animals that are weak, exhausted, have facial asymmetry, continuous shaking movements, hernias, or are unstable, dead on arrival, or died after arrival to a central collection point (Iulini et al., 2012). Hernias would be documented as a "lump" as previously described in the Injuries and Integuments section because diagnosing a hernia was not possible due to the inability to physically examine the cattle. Furthermore, other conditions were added to the new assessment tool, which included descriptive signs of neurological diseases or cattle that were dead on arrival. Iulini et al. (2012) used these symptoms to classify bovine spongiform encephalopathy (BSE) cattle in Italy for the purposes of disease surveillance. However, specific neurological diagnoses were not included in the new tool as there was no way of assessing this accurately through observation alone. Cattle with suspected nervous disorders are often assessed by a veterinarian and sometimes require additional laboratory testing to confirm diagnosis (Canadian Food Inspection Agency, 2013b). CFIA regulations were still followed when discerning if the animal was compromised or unfit when evaluating hernias, suspected nervous disorders, or weakness.

#### 2.2.3.11 Compromised Condition (CC) Scale

Initially, the CC Scale was measured using a visual analog scale (VAS). The VAS has been previously used to document behavioural responses to painful procedures (castration) in cattle (Moya et al., 2014). Animals are scored using a 10-cm horizontal line, with the far left (0-cm mark) indicating no pain response and the far right (10-cm mark) representing an extreme pain response (Ludington and Dexter, 1998). In the present study it was used as an indicator of fitness for transportation rather than pain; the far left (0-cm mark) indicating fit for transportation and the far right (10-cm mark) representing unfit for transportation (Table 2-1). This scale allowed the researchers to combine all of the conditions being assessed and observed into a single score. For ease of use, the VAS was translated into a five-point scale by evenly dividing the 10 cm scale amongst five points to eliminate excess recording sheets when being handled by one observer that typically assessed hundreds of animals per site visit as shown in Table 2-1. The five-point scale was as follows: normal (1), mild (2), moderate (3), severe (4), and unfit for transport (5) (Table 2-1). Where scores of one and two indicated that the animal was fit for transportation, scores of three and four indicated that the animal was compromised, and a score of five indicated that the animal was unfit for transportation. To facilitate statistical analysis, the

five-point scale was further condensed into a three-point scale of fit for transportation (1), compromised (2), and unfit for transportation (3) (Table 2-1).

The research team developed this scale to capture the researcher's overall impression of whether or not an animal was fit for transportation, taking into consideration the multiple conditions that could affect a particular animal. For example, in most cases one condition alone would not be enough to deem the animal compromised or unfit (e.g. Mobility Score = 2). However, the observation of other conditions (e.g. animal is also weak or unstable) strengthened the justification to consider the animal compromised or unfit according to the transport regulations (Health of Animals Regulations, 2017; Canadian Food Inspection Agency, 2013b). The inclusion of a CC Scale allows the observer to take into account the severity of individual conditions and or the combined effect of multiple conditions to provide an overall assessment of fitness, which is lacking in the current CFIA regulations.

#### 2.2.3.12 Marketing Endpoints of Compromised and Unfit Cattle

The CFIA regulations provide recommendations regarding marketing endpoints including: local transportation for slaughter, transportation for veterinary diagnosis and treatment, or on site euthanasia (Canadian Food Inspection Agency, 2013a). However, the CFIA does not police or fine producers for inappropriate decisions regarding the marketing endpoints of compromised and unfit cattle (Canadian Food Inspection Agency, 2013a). Appropriate marketing endpoints are an integral part of ensuring good animal welfare for compromised and unfit cattle, and for this reason information about how cattle were managed in this regard was recorded in the tool. The fate of compromised or unfit cattle may vary by the location that the animal arrives to auctions and abattoirs as these facilities have inherently different endpoints for cattle in these conditions. Categories for marketing endpoints included: sold in sale, returned to owner, refused, transported to nearest abattoir for regular slaughter, regular slaughter, on-site euthanasia with salvage, and on site euthanasia with no salvage.

### 2.2.4 Main Study: Data Collection

The main study was conducted over a one-year period between April 1, 2016 and March 31, 2017. Prior to the commencement of the main study, three researchers were trained to use the assessment tool developed as part of the pretest. The same auction and abattoir participants used during the pretest were also used in the main study. Two researchers conducted assessments at

each auction market six times within the year and at each provincial and federal abattoirs nine times within the year (once every six to eight weeks). The sites were divided evenly between observers. Once during each sampling cycle (six to eight weeks) both researchers visited one auction market and one provincial abattoir together and both researchers were present during all federal abattoir visits to determine inter-observer reliability for assessing cattle conditions. During joint visits, the same cattle were assessed by both observers, if there was poor agreement (defined in the statistics section) between the observers the research team would meet to discuss what modifications were required and additional training to improve observer agreement would be done immediately. The six to eight week cycle was also used to account for seasonal trends in the cattle market. The seasons were divided among Winter (January-April), Summer (May-August), and Fall (September-December) where two site visits per season were made to each selected auction market and three site visits per season made to selected provincial and federal abattoirs.

A random subset of cattle were assessed within their holding pens at each site visit prior to sale or slaughter with the exception of provincial abattoirs where all cattle at each abattoir were assessed to meet the required minimum sample size. In the main study, a total of 4561 cattle were assessed based on six site visits to each of the eight selected auction markets within the year observing 20 % of cattle at low sale volume auctions (n = 692 cattle) and 80 % of cattle at high volume auctions (n = 2766 cattle). At each high and low volume site visit, approximately 400 and 100 cattle were assessed, respectively. At the 11 provincial abattoirs, a total of 1069 cattle were assessed based on nine site visits within the year observing 10 % of the cattle at low slaughter volume abattoirs (n = 346), 20 % of cattle at medium slaughter volume abattoirs (n = 692 cattle), and 70 % of cattle at high slaughter volume abattoirs (n = 2421 cattle). All cattle were assessed at provincial abattoir site visits in order to try and meet the minimum sample size required. Lastly, at the participating federal abattoir a total of 4013 cattle were assessed based on nine site visits within the year. Approximately 400 cattle were assessed at each federal abattoir site visit. The total number of cattle assessed at each auction and the federal abattoir site was determined based on the sale or kill volume occurring that day and random selection of liners or pens would be made during the assessment (e.g. every fifth pen, or every fourth cattle liner). Cattle were not assessed during handling or in assembly for slaughter due to the effects of handling on cattle behaviour and ease of observer assessment. The exception to this was the

federal abattoir, as the only chance to clearly observe the cattle was at the time of unloading and or walking to lairage. As each researcher only observed some of the same cattle, only the scores of the researcher assigned to the site were used in the final data set after inter-observer reliability was evaluated.

### 2.2.5 Main Study: Sample Size and Stratification

A sample size calculation was conducted to determine the minimum number of cattle that needed to be assessed within each population (auctions, provincial and federal abattoirs) and subcategory (low, medium, and high throughput auctions and abattoirs) to ensure statistical power and scientific validity (Browner et al., 2013). The calculation was based on the proportion of cattle being sold or slaughtered annually and the composition of location types within AB. The calculation used an expected prevalence of 10 %, confidence interval of 95 % and a precision of 1 %. This was based on the information obtained from the pretest using provincial abattoir information from a total population of 936 head of cattle with the following prevalence of compromised conditions: 10 % injury, 23 % lameness, 8 % body condition score of less than two and/or weakness. Based on the sample size calculation a minimum number of cattle to be sampled was 3458 head for each population (auction markets, provincial abattoirs, and the federal abattoir) over the year.

Sampling was further stratified by age to represent 80 % feeder/fat cattle and 20 % mature cattle that would be assessed at each site, which is representative of the distribution of cattle typically seen at central collection points in each population (Alberta Agriculture Data and Rural Development, 2013).

### 2.2.6 Statistical Analysis and Data Management

#### 2.2.6.1 Pretest

Data from the collection sheets of both researchers was entered into Microsoft Excel (2011 ver. 14.7, Redmond, WA) and stored into a Microsoft Access database (2013 ver. 15.0, Redmond, WA). The Cohen's kappa statistic was used to calculate an inter-rater reliability (IRR) score between two observers. A weighted kappa value of 0.85 was used as the cut-off value to review training with observers or examine the scoring tool being used. The federal abattoir data was not included in the final pretest data set due to poor visibility that made it difficult to track and observe cattle (specifically in order to successfully observe any injuries, eye

conditions, or udder conditions). However, the visit was still useful in terms of selecting a more appropriate location (ground level) to successfully observe cattle.

#### 2.2.6.2 Main Study

Data analysis was conducted using (StataCorp, 2015)A descriptive analysis was performed on all conditions and fitness for transportation ("fit', "compromised", and "unfit"). The descriptive analysis was also used to document conditions and fitness for travel by location type (auction market cattle, provincial and federal abattoir cattle) and age or sex-specific individual animal-level characteristics (penis injuries, calving, vaginal and uterine prolapses, and cattle in heavy lactation).

## 2.3 Results

### 2.3.1 Pretest

Weighted kappa (κ) values for body condition, respiratory, mobility and mud scores were 0.87, 0.91, 0.97 and 0.79, respectively (Table 2-2). All other conditions were dichotomous, and therefore could not be used as part of the IRR, the information was still collected and cross referenced between observers to ensure they were observing the same conditions and severity. As the mud score IRR did not meet the cut-off criteria of 0.85 it was modified from a four-point scale to a two-point scale in which a score of 1 indicated mud only covering limbs and a score of two indicated mud covering limbs, belly and sides to improve the repeatability of the score and assist in the ease of statistical analysis in the main study (Table 2-2). This modification of the mud scale resulted in an improved IRR value of ($\kappa = 0.87$; Table 2-2) which was greater than the defined cut-off of 0.85 and therefore the modification was retained.

The CC scale in the pretest was assessed as a 5-point scale and had a weighted kappa value of 0.92 (Table 2-2). To improve the utility of the CC scale for prevalence data analysis it was further condensed to a three-point scale; fit (1), compromised (2), and unfit (3), which resulted in an improved IRR ($\kappa = 0.95$; Table 2-2). This score ultimately accounted for all the compromised and unfit conditions and their severity, which will be described in detail below.

### 2.3.2 Main Study

#### 2.3.2.1 Prevalence of Compromised and Unfit Cattle

Descriptive statistics regarding the age, type, and sex of cattle observed at AB auction markets, provincial abattoirs, and federal abattoir are presented in Tables 2-3 and 2-4. Tables 2-3 and 2-4 are used to give the reader a sense of the population demographic of cattle that were assessed at participating locations within AB. The prevalence of compromised and unfit cattle (CC Score) arriving at auction markets was 4.3 % (197 of 4561) and 0.4 % (16 of 4561), respectively (Table 2-5). The most common conditions observed were: in heavy lactation (3.2 %; 95 of 2965; Table 2-3) penis injury (2.4 %; 6 of 253; Table 2-3) and emaciation (1.6 %; 75 of 4561; Table 2-6). Conditions with a prevalence of less than 1.0 % included: bloat (0.02 %; 1 of 4561), lameness (1.0 %; 46 of 4561), severe injuries (0.37 %; 17 of 4561), weakness (0.2 %; 11 of 4561), severe eye health conditions (0.04 %; 4 of 4561), and respiratory issues (0.09 %; 2 of 4561; Table 2-6). Of those cattle that were identified as lame, 1.6 % (39 of 4561) were classified as moderately lame, 0.2 % (6 of 4561) severely lame, and 0.04 % (1 of 4561) were non-ambulatory (Table 2-6). Severe injuries were most prevalent on the body (0.02 %; 1 of 4561), head (0.2 %; 8 of 4561), and limbs (0.2%; 8 of 4561; Table 2-6). No prolapses, cows imminently calving, or multiple severe injuries were observed at any of the participating auction markets during the study (Table 2-6).

Provincial abattoirs had a prevalence of 18 % (192 of 1069) cattle arriving in compromised condition and 2.5 % (27 of 1069) arriving unfit (Table 2-5). The animals identified as compromised or unfit were lame (15.2 %; 162 of 1069), had a severe injury (8.3 %; 89 of 1069), respiratory issues (2.0 %; 21 of 1069), weak (1.3%; 14 of 1069), or were emaciated (1.0 %; 11 of 1069; Table 2-7). Of those cattle that were lame, 9.5 % (101 of 1069) were classified as moderately lame, 5.6 % (60 of 1069) as severely lame, and 0.1 % (1 of 1069) were non-ambulatory (Table 2-7). Of cattle having severe injuries, 7.4 % (79 of 1069) occurred on the limbs, 0.6 % (6 of 1069) on the body, 0.3 % (3 of 1069) on the head while 0.1 % (1 of 1069) had multiple severe injuries (Table 2-7). Conditions with a prevalence of less than 1.0 % included: bloat (0.65 %; 7 of 1069), calving (0.21%; 1 of 472; Table 2-2), severe eye health conditions (0.84 %; 9 of 1069), cattle in heavy lactation (0.85 %; 4 of 472; Table 2-2), and a vaginal prolapse (0.21%; 1 of 472; Table 2-2). No penis injuries were observed at the participating provincial abattoirs during the study (Table 2-7).

The prevalence of compromised cattle arriving at the one federal abattoir assessed in the study was 1.8 % (73 of 4013) while the prevalence of unfit cattle was 0.1 % (5 of 4013) (Table 2-4). The prevalence of specific compromised and unfit conditions was: lame (1.5 %; 61 of 4013), emaciated (0.2 %; 8 of 4013) severe injuries (0.1 %; 5 of 4013), respiratory issues (0.07 %; 3 of 4013), weak (0.05 %; 2 of 4013), severe eye health conditions (0.05 %; 2 of 4013), and bloated (0.02 %; 1 of 4013; Table 2-8). Of those cattle identified as lame, 1.4 % (56 of 4013) were moderately lame, 0.1 % (4 of 4013) were severely lame, and 0.03 % (1 of 4013) were non-ambulatory (Table 2-8). A total of 0.07 % (3 of 4013) of severe injuries were located on the head, 0.05 % (2 of 4013) on the limbs, and no severe injuries to the body or multiple severe injuries were observed (Table 2-8). There were no observations of cattle imminently calving, in heavy lactation, having penis injuries, or prolapses at the federal abattoirs (Table 2-8).

### 2.3.3 Marketing Endpoints for Compromised and Unfit Cattle

Of those cattle arriving in a compromised condition at an auction market (n=175), 98.3 % (172 of 175) were sold in the sale, and 1.7 % (3 of 175) were transported locally to an abattoir for salvage slaughter (Table 2-9). Of cattle arriving in an unfit condition (n=15), 86.3 % (13 of 15) were sold in the sale, 6.3 % (1 of 15) were refused at the unloading dock prior to unloading, and 6.3 % (1 of 15) were returned back to the original consignor (Table 2-9).

Cattle arriving at provincial abattoirs continued for regular slaughter (99.7 %), salvage slaughtered in their holding pen (0.19 %), or euthanized with no salvage of the carcass (0.1 %) (Table 2-10). Of the cattle that arrived in a compromised condition at a provincial abattoir (n = 192), 100 % (192 of 192) were slaughtered. Of the cattle that arrived in an unfit condition (n=27) 88.9 % (24 of 27) continued on for regular slaughter, 7.4 % (2 of 27) were slaughtered in the holding pens at the facility to salvage the carcass, and 3.7 % (1 of 27) were euthanized in the holding pens with no salvage of the carcass (Table 2-10).

In the federal abattoir, all the cattle that arrived in a compromised condition (n = 73) continued for regular slaughter, while of those arriving in unfit conditions (n = 5) only 60.0 % (3 of 5) continued on for regular slaughter (Table 2-11). The remaining 40.0 % (2 of 5) of unfit cattle were euthanized in their holding pens at the facility with no salvage of the carcass (Table 2-11).

## 2.4 Discussion

### 2.4.1 Pretest

No major issues were encountered in observing and or identifying any of the indicators included in the final assessment tool. In addition, the IRR of all scores were above the selected weighted kappa value of 0.85 indicating that assessors with cattle experience or those trained to identify the conditions described in the tool could use the tool effectively and repeatedly over time. Deming et al. (2013) also used a kappa value of 0.85 to determine IRR of two observers scoring lameness in dairy cattle. Vasseur et al. (2014) indicated that assessor training and development of standard operating procedures (SOPs) help to ensure observer repeatability as the number of assessors using a tool increases. Furthermore, the new assessment tool incorporated the severity of several conditions to determine if an animal was fit for transportation without the need for further clinical assessment or laboratory testing. Ultimately this will aid producers, as well as auction market and abattoir owners and employees to be more consistent in making proper loading and marketing endpoint decisions of compromised and unfit cattle.

### 2.4.2 Main Study

For ease of comparison the prevalence of specific conditions will be discussed separately rather than prevalence by location type as some of the conditions listed below were not observed at all locations.

#### 2.4.2.1 Prevalence of Compromised and Unfit Cattle

The results of this study provide clear evidence that compromised and unfit cattle are still arriving to all central collection points in AB. Provincial abattoirs had the highest prevalence of compromised (18.0 %) and unfit cattle (2.5 %). This confirms that compromised cattle are being managed according to the Canadian transport regulations, which state that compromised animals may only be transported locally for slaughter, to be euthanized, or receive care by a veterinarian (Canadian Food Inspection Agency, 2013a). Local transport refers to the closest available abattoir for slaughter that can provide producers a humane way of culling compromised or poor doing cattle before their condition progresses to the point that the animal is considered unfit. It is important to acknowledge that compromised cattle may be transported employing special provisions such as transporting the animal in a separate compartment within the trailer, which may help to minimize undue suffering (Canadian Food Inspection Agency, 2013a). According to

the CFIA regulations, it is unacceptable to transport an unfit animal for any reason other than for veterinary care. However, the results of this study indicate that unfit cattle (27 of 1069) were observed at provincial abattoirs. Ultimately it is important to make good loading decisions on farm to reduce pain or suffering in transported animals with chronic conditions that may already be considered compromised or unfit (Grandin, 2017). Poor loading decisions may be due to the lack of producer knowledge regarding what conditions are appropriate for transport, or transportation itself has dramatic effects on severely compromised cattle causing them to become unfit. González et al. (2012b) reported that the incidence of compromised cattle at the time of loading was 0.005%. Cattle that became lame, non-ambulatory, or dead on arrival to their final destination had a cumulative incidence of 0.049%, which is lower than observed in the current study (González et al, 2012b). This is most likely due to that fact that the majority of cattle observed in that study were fat cattle destined for slaughter at large federal slaughter plants.

#### 2.4.2.2 Nutrition

##### 2.4.2.2.1 Bloat

The prevalence of bloat observed at all location types was relatively low (< 1 %), however, it was found to be greatest (0.7 %) in cattle arriving to provincial abattoirs. Low bloat prevalence is likely due to the fact that it is a digestive disorder most commonly reported in feeder/fat rather than mature cattle and whose onset can be rapid and highly fatal in comparison to other diseases (Galyean, 2003). Digestive disorders such as acidosis and bloat have been reported to account for 25 to 33 % of deaths occurring at feedlots (Galyean, 2003). Cheng (1998) reported a mortality prevalence caused by bloat ranging between 0.1 % and 0.2 % at a 16,396 head feedlot. Therefore it is not surprising that the prevalence of bloat in the current study is extremely low because cattle usually succumb to the disease before they are transported.

##### 2.4.2.2.2 Emaciation

Emaciation was observed at all location types and its prevalence ranged between 0 and 1.6 % with the greatest occurrence in auctions and provincial abattoirs. It is important to note that the prevalence of emaciation was greatest in mature, dairy, and female cattle in the current study. A US study reported that the mean BCS for mature beef cows and bulls arriving at auctions ranged between 4.7 and 5.3 (on a nine-point scale), and for mature dairy cows and bulls ranged between 2.6 to 2.9 (on a five-point scale) (Ahola et al., 2014a). This finding suggests that

mature dairy cattle have a lower average body condition than mature beef cattle, which is also in agreement with a recent Canadian study indicating the prevalence of emaciation (BCS less than or equal to 1.5) to be 1.70 % in mature cattle arriving to federal abattoirs (Goldhawk et al., 2015). Mature cattle are more likely to be culled from the herd due to old age or poor health, which can be associated with extreme weight loss (Waldner et al., 2009). However, cattle must be culled prior to becoming emaciated to ensure good welfare outcomes during transport (Grandin, 2001).

#### 2.4.2.3 Depression/Attitude and Respiratory Issues

In the current study respiratory issues had a prevalence of < 1 % in both auction markets and federal abattoirs, and 2.0 % in provincial abattoirs, which was largely observed in beef feeder/fat animals. Edwards (2010) documented respiratory illness reporting a morbidity rate of 70 % to 80 % and mortality rate of 40 % to 50 % in US feedlots (backgrounding and finishing) that accounts for substantial losses in feedlot performance, health, and carcass quality. Recently weaned calves and newly received feeder cattle are at high risk of respiratory illness. This is often due to multiple stressors (transport, recently weaned, commingling, possible castration and dehorning) that can overwhelm the immune system and cause cattle to reduce their feeding efficiency (average daily gain) and prognosis if not treated immediately (Smith, 2008; Griffin, 2014). Feedlot cattle that do not respond to antibiotic treatment can succumb to the rapid progression of respiratory illness (Quimby et al., 2001). These types of cattle are often shipped locally for immediate slaughter rather than sold in auction. The results of the current study suggest fewer cattle with respiratory issues were observed at auctions compared to local abattoirs where they would most likely be shipped for slaughter due to their poor response to treatment.

#### 2.4.2.4 Mobility Issues and Weakness

Lameness in dairy cattle is well documented as a major health and serious welfare problem (Von Keyserlingk et al., 2009; Hemsworth et al., 1995; Solano et al., 2015). The incidence of lameness in dairy cattle has been reported to range between 0 and 31 % having a mean incidence of approximately 7 % (Hemsworth et al., 1995). Total prevalence of lameness in both beef and dairy cattle in the current study was 1.0 % in auction markets, 15.2 % in provincial abattoirs, and 1.5 % in the federal abattoir. The incidence of lameness reported by Hemsworth et al. (1995, was similar to that found in the current study even though their study only assessed

dairy cattle while the current study included both beef and dairy cattle. A study assessing the incidence of lameness in southern Alberta feedlots found that on average 37% of cattle within chronic pens (Tessitore et al., 2011) and 9.4 % (Schwartzkopf- Genswein et al., 2015) of cattle within healthy pens were lame.

The prevalence of non-ambulatory cattle observed at all location types was relatively low (< 1.0 %) with two instances occurring in beef animals at a provincial and federal abattoir and one instance occurring in a dairy animal at an auction market. The low prevalence may be attributed to the small percentage of compromised cattle that may become non-ambulatory over the course of their transport journey. A study by González et al. (2012b) assessing welfare outcomes in cattle during long-haul transportation found that cattle originating from auction markets were more likely to become non-ambulatory, than cattle loaded at feed yards. A Canadian study assessing 19 slaughter facilities reported that 90 % of non-ambulatory cattle were dairy breeds, and the remaining 10 % were beef breeds (Stull et al., 2007). The same study also reported a non-ambulatory incidence between 0.7% and 1.1% in beef cattle, between 1.1% and 1.5% in dairy cattle (Stull et al., 2007). Goldhawk et al. (2015) reported a non-ambulatory prevalence of 0.4 % in mature beef cattle arriving to a federal abattoir. The main causes of an animal becoming non-ambulatory include clinical hypocalcemia, calving-related injuries or paralysis, and injuries from slipping and falling (Stull et al., 2007). These conditions are also associated with weakness in cattle (Stull et al., 2007). In the current study, < 1 % of cattle arriving to auctions and federal abattoirs arrived in a weakened condition while 1.4 % of cattle arriving to provincial abattoirs were arriving in a weakened condition. This difference in prevalence between location types can be explained by the fact that more compromised and unfit cattle are arriving at provincial abattoirs than auctions and federal abattoirs. Ahola et al. (2014b) reported that cattle arriving to auction markets with soreness in their hips had an increased likelihood of becoming non-ambulatory during transport. This suggests that cattle with moderate lameness should be transported directly to slaughter at a provincial abattoir. However, animals with severe lameness should be euthanized on site for salvage. Non-ambulatory or weak cattle have a very poor prognosis and euthanasia should not be delayed if there is no hope of improvement (Stull et al., 2007).

#### 2.4.2.5 Udder Conditions

The current study is the first to report the prevalence of female cattle arriving at central collection points in heavy lactation, which was found to range between 0 and 3.2 %. Although Goldhawk et al. (2015) documented that 10 out of 12 loads of cattle had mature cows with poor or torn udder conditions they did not assess if the cattle were lactating. Mature female cattle arriving in heavy lactation was most prevalent at auction markets and provincial abattoirs. However, no mature dairy cattle were observed during this study at the federal abattoir simply because the plant did not purchase any for slaughter, and mature dairy cattle are typically shipped into the US for slaughter (N. Simmons Personal Communication, 2017).

#### 2.4.2.6 Eye Health Conditions

Severe eye health conditions were observed at all location types and had a prevalence < 1.0 %. Goldhawk et al. (2015) reported a similar prevalence (1.2 %) of severe ocular injuries resembling OSCC in mature cattle arriving to a federal abattoir. One difference between the current study and that reported by Goldhawk et al. (2015) is that their study reported a prevalence specific to OSCC, while the current study also considered blindness as part of the severe eye health conditions based on the criteria set out by the CFIA (Canadian Food Inspection Agency, 2013b). However, this difference resulted in minimal discrepancy in the prevalence values observed between the two studies. If the OSCC is too advanced it often results in large market discounts on the cattle as they are more likely to result in whole carcass condemnation (Ahola et al., 2014b). Consequently it is of benefit to both producers and the animal to market these cattle when the ocular lesion is in a precancerous stage (Goldhawk et al., 2015).

#### 2.4.2.7 Injuries and Integuments

In the current study, cattle arriving with severe injuries had a prevalence of 8.3 % at provincial abattoirs, and < 1.0 % at the auction markets and federal abattoir. The majority (79 out of 89; 88.8 %) of injuries reported at the provincial abattoirs occurred on the limbs, likely explaining some of the causes of lameness. Goldhawk et al. (2015) reported a body injury prevalence of 1.0 % in mature cattle arriving to a federal abattoir, which was similar to that reported in the current study. It should be noted that both feeder/fat and mature cattle were observed in the current study while Goldhawk et al. (2015) only looked at mature cattle.

#### 2.4.2.8 Reproductive Health Conditions

##### 2.4.2.8.1 Calving

Prevalence of calving heifers/cows was low (0.2 %) in provincial abattoirs, and this condition was not observed in any of the auction markets or the federal abattoir participating in the study. The only calving animal observed was a heifer (feeder/fat) that was transported to a provincial abattoir. However, transportation is not recommended for pregnant cattle late in pregnancy (Canadian Food Inspection Agency, 2013b). One US study found the prevalence of pregnancy in feedlot heifers (24,658) arriving at a slaughter plant to be 6.0 % and 4.4 %, respectively over a two year period (Laudert, 1988). The USDA (2011) also reported similar pregnancy prevalence (7.6 %) in heifers arriving to slaughter plants. Although these studies provide an indication about the rates of pregnancy neither study was designed to assess the number of females that were imminently calving. Pregnant heifers not only pose an economic liability to producers, but also to processors since heifers are considered compromised if they are likely to give birth during transportation (Rademacher et al., 2015).

##### 2.4.2.8.2 Prolapses

Prolapses were only observed in provincial abattoirs and had a prevalence of 0.2 %. The one reported prolapse was a vaginal prolapse in a mature beef cow. No rectal prolapses were observed in this study. This is consistent with the findings of Ahola et al. (2014b) who assessed beef cows arriving to auctions in the US with a prolapsed vagina or rectum. Grohn et al. (1990) reported an incidence of 0.1 % for prolapsed vaginas in lactating dairy cattle, which is similar to the values reported in the current study. Miesner and Anderson (2008) reported that vaginal prolapses can be acute or chronic and may occur pre- or post-partum, but are often a reason for culling cattle because of heritability and frequent reoccurrence.

##### 2.4.2.8.3 Penis Injuries

Penis injuries in intact males were only observed at auction markets and had a prevalence of 2.4 % (Table 2-4). These injuries are a common issue with beef bulls that can result in large economic losses to producers if bulls are not able to breed (McDiarmid, 1981). McDiarmid (1981) examined the breeding soundness of 278 bulls and found that 2.5 % of them had genital organ deformities, which included penis injuries. Desrochers et al. (1995) reported that beef bulls such as Angus and Herford breeds were more susceptible to penis injuries than other breeds with

a prevalence of 27 % and 22 %, respectively. They also, reported that this condition was observed in bulls ranging in age from one to five years. Penis injuries are difficult for producers to manage, as it requires surgical intervention that has a low success rate (based on return to reproductive soundness) between 76 and 87 % (Desrochers et al., 1995). Therefore, producers are more likely to cull bulls with penis injuries as their full recovery is not guaranteed. All instances of penis injuries observed at auction markets occurred in mature (older than finished weight cattle) beef bulls. Dairy cattle, particularly bulls, were rarely observed during this study (Table 2-4).

#### 2.4.2.9 Marketing Endpoints of Compromised and Unfit Cattle

As compromised and unfit cattle are arriving to central collection points it is highly important that appropriate marketing endpoints be employed. The majority (98 %) of compromised cattle arriving to auction markets were sold while the remainder were transported locally for slaughter. Although compromised cattle should only be transported locally for slaughter it is common for cattle buyers hired by large processors to purchase and assemble loads of cull cattle arriving to auction markets (E. Janzen Personal Communication, 2016). This practice explains why the majority of compromised cattle continue to be sold instead of transported for local slaughter. Surprisingly, the majority (86.3 %; 13 of 15) of unfit cattle observed at the auctions were sold while the remainder were either refused at the unloading dock (6.3 %; 1 of 15), or returned home to the original consignor (6.3 %; 1 of 15). None of these marketing endpoints are appropriate for unfit cattle, as the HAR clearly indicates that unfit cattle must be euthanized (Health of Animals Regulations, 2017). Transport of these cattle represents the greatest breech in animal welfare by law.

Of the compromised cattle arriving at provincial abattoirs, all of the cattle were able to go on for regular slaughter. Similarly, the majority (88.9%) of unfit cattle continued on for regular slaughter. Two out of five animals that arrived at a provincial abattoir in an unfit condition were euthanized in the holding pen, one carcass was salvaged and the other carcass was not salvageable and consequently sent for rendering. Ahola et al. (2014b) also emphasized that culling cattle in a timely manner assures that cattle maintain their salvage value at slaughter.

A recent survey conducted by Moggy et al. (2017) reported that 13 % of producer respondents did not euthanize cattle on farm. Furthermore, the decision to euthanize cattle on farm was difficult for producers and veterinary advice was often sought. Several factors

influenced producer decisions to euthanize cattle; 73 % of producers indicated the animal's likelihood of recovery and 64 % of indicated the degree of pain or distress that the animal was under as reasons for euthanasia. Producers were less likely to euthanize cattle on farm if they were salvageable and able to be transported locally for slaughter (Moggy et al., 2017).

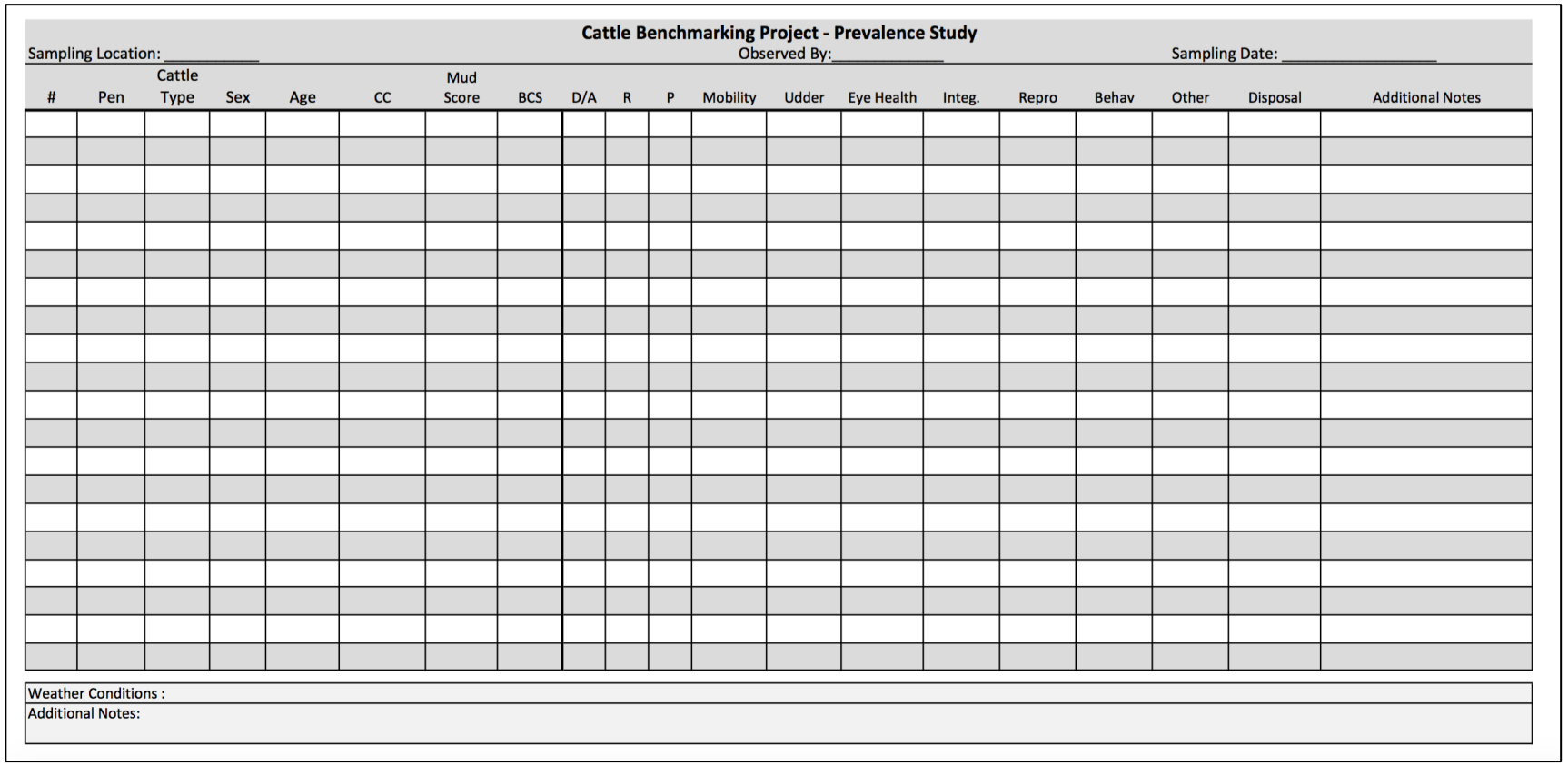
### 2.4.3 Conclusions

This study is the first to document the prevalence of compromised and unfit conditions occurring in AB auction markets and abattoirs. It provides information about what are the most prevalent causes of compromised and unfit cattle at the main collection points, and consequently provides insight for where producer education is required to properly manage compromised and unfit cattle. The minimum number of cattle observed (based on the power calculations) in provincial abattoirs was not met (1069 cattle actually observed from expected 3458), which could have resulted in inflated prevalence values. Animals that were euthanized on farm, bled, and hauled into provincial abattoirs (shoot and bleeds) were not recorded in this study and should be considered as an additional method of culling in future work.

Although loading conditions prior to transport were not recorded in this study, they could provide valuable information about the effects of transport on the outcomes of cattle arriving to their destination in a compromised or unfit condition (Goldhawk et al., 2015). Studies investigating the relationship between animal fitness (compromised and unfit) and carcass quality and yield would be useful in determining whether compromised cattle actually have economic value for the processor and or producer. Furthermore, determining what conditions are considered salvageable for human consumption would provide further guidance to producers regarding decisions about fitness for transport. While unfit cattle are not fit for transportation, a possible solution may be the use of mobile butchers to have the animal humanely slaughtered on site.

The overall prevalence of compromised and unfit cattle is relatively low suggesting that the industry is doing a fair job of managing these animals appropriately however, improvements are still needed. Reducing the prevalence of compromised and unfit cattle will only be realized through continued producer education including surveillance and proper transportation decisions as well as providing them clear criteria for what constitutes fitness for travel. Communication regarding these criteria should also incorporate other industry stakeholders including inspectors, processors, and auction and abattoir owners.

**Figure 2-1.** Data collection sheet designed to collect information regarding prevalence and characteristics associated with compromised conditions of cattle upon arrival to auction markets, provincial and federal abattoirs within Alberta[1].



**Cattle Benchmarking Project - Prevalence Study**

Sampling Location: _____ Observed By: _____ Sampling Date: _____

| # | Pen | Cattle Type | Sex | Age | CC | Mud Score | BCS | D/A | R | P | Mobility | Udder | Eye Health | Integ. | Repro | Behav | Other | Disposal | Additional Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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Weather Conditions :

Additional Notes:

[1] CC= Compromised Cattle Score; BCS= Body Condition Score; D/A= Depression Attitude Score; R= Respiratory Issues; P= Indicators of Pain; Integ= Injuries and Integuments; Repro= Reproductive Health Conditions; Behav= Abnormal Behaviour

**Figure 2-2.** Detailed data collection sheet designed to collect specific information regarding the severity and characteristics associated with compromised conditions of cattle upon arrival to auction markets, provincial and federal abattoirs within Alberta.

**Auction/Abattoir:** **Compromised Cattle Capture Form** **Date:**

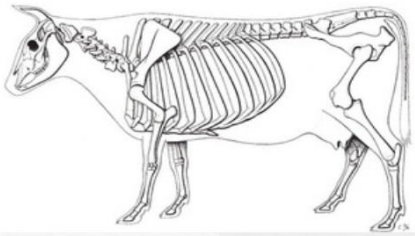
**General Information**
**Age:** Calf / Feeder / Mature **Sex:** Female / Steer / Bull **Cattle Type:** Beef / Dairy
**Animal #:**_____ **Pen #:**_____ **# of Head in Lot:** _____ **Animal Mud Score:** 1 2 3 4
**Compromised Cattle Evaluation:** Normal / Mild / Moderate / Severe / Unfit

**Compromised Conditions**

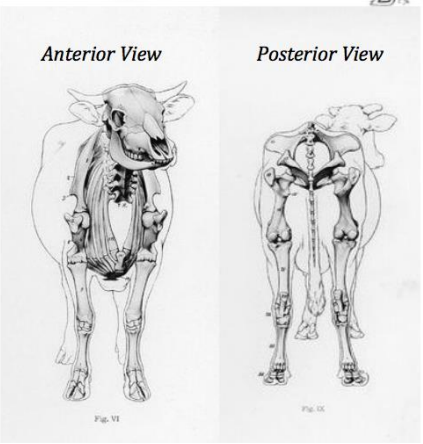
***Nutrition:***
**Body Condition Score**: 1 2 3 4 5
☐ Bloat/Overload

***Trauma:***
****Circle general location of trauma or injury on diagrams and define affected side(s)****
**Check all of the following that apply:**
☐ Bone Fracture ☐ Broken Horn(s)
☐ Wound
☐ Open ☐ Closed ☐ Partly Healed/Scabbed Over
☐ Large ☐ Medium ☐ Small
☐ Swelling ☐ Redness ☐ Smell ☐ Hair Loss
☐ Discharge from injury site:
☐ Serous ☐ Prulent ☐ Blood
☐ Not Healed After Surgery;
Describe Thought Procedure :_____

*Midsagittal View*



*Anterior View* *Posterior View*



***Mobility:***
**Mobility Score:** 1 2 3 4 5
☐ Split or Hobbled ☐ Ataxic ☐Stiffness ☐No Mobility
☐Non-Weight Bearing ☐Muscle Atrophy
☐ Missing Limb(s) or Foot (Feet)
☐ Abnormal Claws (Back / Front / Both)
☐ Corkscrew ☐ Excessively Long ☐ Scissor

***Respiratory:***
**Respiratory Score:** 0 1 2 3 4
**Attitude Score:** 0 1 2 3
☐ Nasal and/or Oral Disrcharge:
☐ Serous ☐ Prulent ☐ Mucous ☐ Blood
☐ Cough ☐ Elevated Respiratory Rate ☐ Neck Stretched Out ☐ Wheezing ☐ Elbows Abducted
☐ Excessive Drooling ☐ Open Mouth Breathing/ Panting ☐ Closed Mouth Heavy Belly Breathing

**Auction/Abattoir:** **Compromised Cattle Capture Form** **Date:**

***Reproductive:***

☐ Prolapse ☐ Penis Injury

**Udder Condition:** Good Poor Torn Poor & Torn Lactating

☐ Imminently/Recently Calved with presence of:

☐ Blood ☐ Placental Membranes ☐ Feet/Water Bag ☐ Newborn Calf ☐ Vulvar Edema

***Eye Health:***

☐ Eye Condition:

☐ Opaque ☐ Tumor Nodules ☐ Missing or Severely Injured ☐ Redness

☐ Excessive Blinking ☐ Swelling

☐ Ocular Discharge:

☐ Serous ☐ Prulent ☐ Mucous ☐ Blood

☐ Affected in ONE or BOTH eyes

IF ANIMAL IS ALONE; is there obvious visual impairment or associated behaviours? ☐ Yes ☐ No

***Behaviour:***

☐ Exhaustion/Weakness ☐ Buller Syndrome

☐ Muscle trembling

☐ Continuous shaking movement ☐ Wobbly ☐ Facial Asymmetry

☐ Unstable (uses other animals or fence for stability or to navigate in environment)

☐ Other abnormal behaviour:_____

***Pain and Stress:***

☐ Belly Kicking ☐ Up & Down ☐Shifting Weight ☐ Foot Stamping ☐ Clenched Tail ☐ Hunched Back

☐ Excessive Tail Swishing ☐ Vocalization ☐ Grinding Teeth ☐ Whole Body Shaking

☐ Abnormal Behaviour (Aggression or Agitation or Unwillingness To Move)

****NOTE: Abnormal behaviour is only exhibited when in the presence of a handler in a neutral area prior to slaughter; no abnormal behaviour maybe recorded when walking to the knock box or to the kill floor because it is deemed an unnatural high stress environment for that animal ****

***Mortality:***

☐ Dead On Arrival (DOA) ☐ Dies While At Facility

***Describe the consequence of the compromised animal:***

☐ Veterinary or Manager Assessment

☐ Transport to Slaughter Facility for Salvage ☐ On Site Euthanasia for Salvage

☐ On Site Euthanasia No Salvage

☐ Sold in Sale ☐ Regular Slaughter ☐ Returned To Owner

Other Comments:

_____

_____

_____

**Table 2-1.** Compromised cattle scale developed from visual analog scale to determine fitness for transportation.

| VAS Scale | Five-point CC Scale | Three-point CC Scale |
|---|---|---|
| 1 cm | Normal | Fit for Transportation |
| 2 cm | | |
| 3 cm | Mild | |
| 4 cm | | |
| 5 cm | Moderate | Compromised |
| 6 cm | | |
| 7 cm | Severe | |
| 8 cm | | |
| 9 cm | Unfit | Unfit for Transportation |
| 10 cm | | |

**Table 2-2.** Inter-rater reliability between two observers calculated for two observers during the pretest for observation pairs, the Kappa value is recorded as a weighted Kappa value (κ).

| Condition | n | Weighted Kappa (κ) |
|---|---|---|
| BCS | 83 | 0.87 |
| Respiratory Score | 83 | 0.91 |
| Mobility Score | 83 | 0.97 |
| Mud Score (4-point Scale) | 69 | 0.79 |
| Mud Score (Binary Scale) | 69 | 0.87 |
| CC Score (5-point Scale) | 83 | 0.92 |
| CC Score (2-point Scale) | 83 | 0.95 |

**Table 2-3.** Summary of cattle observed at central collection points based on cattle type and sex demographic.

| **Cattle Age/Sex** | **Number of Cattle Observed at Auction Markets** | **Number of Cattle Observed at Provincial Abattoirs** | **Number of Cattle Observed at the Federal Abattoir** |
|---|---|---|---|
| Mature Cows | 1205 | 137 | 1130 |
| Mature Bulls | 167 | 23 | 0 |
| Mature Steers | 4 | 10 | 1 |
| Feeder/Fat Steers | 1339 | 521 | 1719 |
| Feeder/Fat Bulls | 86 | 43 | 21 |
| Feeder Heifers | 1759 | 335 | 1142 |
| Young Calves | 1 | 0 | 0 |
| **Total** | **4561** | **1069** | **4013** |

**Table 2-4.** Summary of cattle observed at central collection points based on cattle type and age demographic.

| Cattle Type/Age | Number of Cattle Observed at Auction Markets | Number of Cattle Observed at Provincial Abattoirs | Number of Cattle Observed at the Federal Abattoir |
|---|---|---|---|
| Dairy Mature | 170 | 12 | 0 |
| Beef Mature | 1206 | 157 | 1131 |
| Dual Purpose Mature | 0 | 1 | 0 |
| Dairy Feeder | 37 | 65 | 173 |
| Beef Feeder | 3145 | 834 | 2709 |
| Beef Young | 1 | 0 | 0 |
| **Total** | **4559[a]** | **1069** | **4013** |

[a] Cattle type does not add up to 4561 due to uncollected data.

**Table 2-5.** Prevalence of compromised and unfit cattle observed arriving at eight Alberta auction markets (N=4561), 11 provincial abattoirs (N=1069), and one federal abattoir (N=4013).

| Compromised Cattle Scale | n | Percent | 95% CI | |
|---|---|---|---|---|
| | | | Lower | Higher |
| **Auction Markets** | **4561** | . | | |
| *Fit* | 4348 | 95.3 | 94.8 | 95.9 |
| *Compromised* | 197 | 4.32 | 3.77 | 4.95 |
| *Unfit* | 16 | 0.35 | 0.22 | 0.57 |
| **Provincial Abattoirs** | **1069** | . | | |
| *Fit* | 850 | 79.5 | 77.0 | 81.8 |
| *Compromised* | 192 | 18.0 | 15.8 | 20.4 |
| *Unfit* | 27 | 2.53 | 1.74 | 3.66 |
| **Federal Abattoir** | **4013** | . | | |
| *Fit* | 3936 | 98.1 | 97.6 | 98.5 |
| *Compromised* | 72 | 1.79 | 1.43 | 2.25 |
| *Unfit* | 5 | 0.12 | 0.05 | 0.30 |

**Table 2-6.** Prevalence of compromised and unfit conditions in observed cattle (N = 4561) arriving to eight Alberta auction markets.

| Auction Market | | | | |
|---|---|---|---|---|
| **Condition[a]** | **n** | **Percent** | **95% CI** | |
| | | | **Low** | **High** |
| Bloat | 1 | 0.02 | <0.01 | 0.15 |
| Calving[b] | 0 | | | |
| Emaciated | 75 | 1.64 | 1.31 | 2.06 |
| Eye Conditions[c] | 4 | 0.09 | 0.03 | 0.23 |
| Lactating[b] | 95 | 3.20 | 2.63 | 3.90 |
| Lameness | 46 | 1.01 | 0.76 | 1.34 |
| *Moderate* | 39 | 0.86 | 0.63 | 1.17 |
| *Severe* | 6 | 0.13 | 0.06 | 0.29 |
| *Non-ambulatory* | 1 | 0.02 | <0.01 | 0.16 |
| Penis Injury[d] | 6 | 2.37 | 1.06 | 5.20 |
| Prolapse | 0 | | | |
| Respiratory Issues | 2 | 0.09 | 0.02 | 0.34 |
| Severe Injury | 17 | 0.37 | 0.23 | 0.60 |
| *Body* | 1 | 0.02 | <0.01 | 0.16 |
| *Head* | 8 | 0.18 | 0.09 | 0.35 |
| *Limb* | 8 | 0.18 | 0.09 | 0.35 |
| *Multiple* | 0 | | | |
| Weak | 11 | 0.24 | 0.13 | 0.44 |

[a] Prevalence has inclusive criteria where an animal may have multiple conditions and calculated in each prevalence as a separate case.

[b] Prevalence calculated for females only.

[c] Includes blindness in both eyes and behaviour consistent with blindness or an ocular mass with or without emaciation.

[d] Prevalence calculated for bulls only.

**Table 2-7.** Prevalence of compromised and unfit conditions in observed cattle (N = 1069) arriving to 11 Alberta provincial abattoirs.

| Provincial Abattoirs | | | | |
|---|---|---|---|---|
| **Condition[a]** | **n** | **Percent** | **95% CI** | |
| | | | **Low** | **High** |
| Bloat | 7 | 0.65 | 0.31 | 1.37 |
| Calving[b] | 1 | 0.21 | 0.02 | 1.50 |
| Emaciated | 11 | 1.03 | 0.57 | 1.85 |
| Eye Conditions[c] | 9 | 0.84 | 0.44 | 1.61 |
| Lactating[b] | 4 | 0.85 | 0.31 | 2.24 |
| Lameness | 162 | 15.2 | 13.1 | 17.4 |
| *Moderate* | 101 | 9.45 | 7.83 | 11.4 |
| *Severe* | 60 | 5.61 | 4.38 | 7.17 |
| *Non-ambulatory* | 1 | 0.09 | 0.01 | 0.66 |
| Penis Injury[d] | 0 | | | |
| Prolapse[e] | 1 | 0.21 | 0.03 | 1.50 |
| Respiratory Issues | 21 | 1.96 | 1.28 | 3.00 |
| Severe Injury | 89 | 8.33 | 6.81 | 10.1 |
| *Body* | 6 | 0.56 | 0.25 | 1.25 |
| *Head* | 3 | 0.28 | 0.09 | 0.87 |
| *Limb* | 79 | 7.39 | 5.96 | 9.12 |
| *Multiple* | 1 | 0.09 | 0.01 | 0.66 |
| Weak | 14 | 1.31 | 0.77 | 2.20 |

[a] Prevalence has inclusive criteria where an animal may have multiple conditions and calculated in each prevalence as a separate case.

[b] Prevalence calculated for females only.

[c] Includes blindness in both eyes and behaviour consistent with blindness or an ocular mass with or without emaciation.

[d] Prevalence calculated for bulls only.

[e] Only vaginal prolapse observed, therefore prevalence calculated for females only.

**Table 2-8.** Prevalence of compromised and unfit conditions in observed cattle (N = 4013) arriving to one Alberta federal abattoir.

| Federal Abattoir | | | | |
|---|---|---|---|---|
| **Condition[a]** | **n** | **Percent** | **95% CI** | |
| | | | **Low** | **High** |
| Bloat | 1 | 0.02 | <0.01 | 0.18 |
| Calving[b] | 0 | | | |
| Emaciated | 8 | 0.20 | 0.10 | 0.40 |
| Eye Conditions[c] | 2 | 0.05 | 0.01 | 0.20 |
| Lactating[b] | 0 | | | |
| Lameness | 61 | 1.52 | 1.18 | 1.95 |
| *Moderate* | 56 | 1.40 | 1.08 | 1.81 |
| *Severe* | 4 | 0.10 | 0.04 | 0.27 |
| *Non-ambulatory* | 1 | 0.03 | <0.01 | 0.18 |
| Penis Injury[d] | 0 | | | |
| Prolapse | 0 | | | |
| Respiratory Issues | 3 | 0.07 | 0.02 | 0.23 |
| Severe Injury | 5 | 0.12 | 0.05 | 0.30 |
| *Body* | 0 | | | |
| *Head* | 3 | 0.07 | 0.02 | 0.23 |
| *Limb* | 2 | 0.05 | 0.01 | 0.20 |
| *Multiple* | 0 | | | |
| Weak | 2 | 0.05 | 0.01 | 0.20 |

[a] Prevalence has inclusive criteria where an animal may have multiple conditions and calculated in each condition as a separate case.

[b] Prevalence calculated for females only.

[c] Includes blindness in both eyes and behaviour consistent with blindness or an ocular mass with or without emaciation.

[d] Prevalence calculated for bulls only.

**Table 2-9.** Marketing endpoints prevalence of observed compromised and unfit cattle (N = 4123)[a] at eight Alberta auction markets.

| Marketing Endpoints | Fit (n=3933) | Compromised (n=175) | Unfit (n=15) | Total (n=4123)[a] | | |
|---|---|---|---|---|---|---|
| | | | | n (Percent) | 95%CI | |
| | n (Percent) | n (Percent) | n (Percent) | | Low | High |
| Sold | 3933 (100) | 172 (98.3) | 13 (86.7) | 4118 (99.9) | 99.7 | 99.9 |
| Refused | 0 | | 1 (6.67) | 1 (0.02) | <0.01 | 0.17 |
| Returned to Owner | 0 | | 1 (6.67) | 1 (0.02) | <0.01 | 0.17 |
| Salvage Slaughter | 0 | 3 (1.71) | 0 | 3 (0.07) | 0.02 | 0.22 |

[a] Totals do not add up to 4561 due to uncollected data.

**Table 2-10.** Marketing endpoints prevalence of observed compromised and unfit cattle at participating Alberta provincial abattoirs (N = 1069).

| Culling Strategies | Fit (n=850) | Compromised (n=192) | Unfit (n=27) | Total (N=1069) | | |
|---|---|---|---|---|---|---|
| | | | | n (Percent) | 95%CI | |
| | n (Percent) | n (Percent) | n (Percent) | | Low | High |
| Regular Slaughter | 850 (100) | 192 (100) | 24 (88.9) | 1066 (99.7) | 99.1 | 99.9 |
| Salvage Slaughter | 0 | | 2 (7.41) | 2 (0.19) | 0.05 | 0.75 |
| Euthanasia | 0 | | 1 (3.70) | 1 (0.09) | 0.01 | 0.66 |

**Table 2-11.** Marketing endpoints prevalence of observed compromised and unfit cattle (N= 4013) at one Alberta federal abattoir.

| Culling Strategies | Fit (n=3935) | Compromised (n=73) | Unfit (n=5) | Total | | |
|---|---|---|---|---|---|---|
| | | | | n (Percent) | 95%CI | |
| | n (Percent) | n (Percent) | n (Percent) | | Low | High |
| Regular Slaughter | 3935 (100) | 73 (100) | 3 (60.0) | 4011 (99.9) | 99.8 | 100 |
| Euthanasia | 0 | | 2 (40.0) | 2 (0.1) | 0.01 | 0.19 |

## Chapter 3. Animal Level Risk Factors of Compromised and Unfit Cattle Arriving at Auctions and Abattoirs in Alberta

*Chapter 3 describes an epidemiological study A year-long epidemiological study was conducted to document characteristics and conditions associated with compromised and unfit cattle. Data was collected using the assessment tool described in Chapter 2. Animal level factors were examined to determine risks associated with factors such as age, cattle type, sex, season, and mud cover. The study found that cattle are still arriving to auction markets and federal abattoirs in compromised and unfit conditions. Mature cattle had greater odds of arriving compromised or unfit than feeder/fat cattle in all location types. Furthermore, dairy cattle had greater odds of arriving compromised or unfit than beef cattle at auction markets and provincial abattoirs. This provides scientific evidence of animal-level risk factors associated with compromised and unfit conditions and consequently some insight for where producer education is required to properly manage compromised and unfit cattle. It is important to consider the age and type of cattle when making loading decisions.*



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**Author contributions:** Heuston, Deither, and Moggy performed site visits, observations, and primary data analysis, and Waldner assisted further data analysis. Heuston, Deither, Moggy, Greter, Moya, Windeyer, Jelinski, Janzen and Schwartzkopf-Genswein assisted with experimental design and manuscript writing.

# CHAPTER 3: ANIMAL LEVEL RISK FACTORS OF COMPROMISED AND UNFIT CATTLE ARRIVING AT AUCTION MARKETS AND ABATTOIRS IN ALBERTA

## 3.1 Introduction

Cow-calf producers most commonly market yearlings or undesirable mature cattle they wish to cull from their herd. Culling decisions are made for several different reasons including poor temperament, health or advanced age (Waldner et al., 2009). The condition of an animal at the time of culling coupled with the transport factors they are exposed to can have a significant impact on their welfare outcomes at the time of off-loading (Goldhawk et al., 2015). It is well known that transportation is stressful (Schwartzkopf-Genswein et al., 2012; Goldhawk et al., 2015; Schwartzkopf-Genswein et al., 2016). Transport factors that can impact cattle welfare outcomes and fitness for transport are numerous and include: loading density; transport duration; trailer design; driver experience; animal handling experience; road and environmental conditions (Schwartzkopf-Genswein et al., 2012; Goldhawk et al., 2015). The type of cattle (i.e. breed, age, sex, auction sourced cattle versus ranch sourced cattle) being shipped can significantly impact their ability to cope with the conditions of transport (Schwartzkopf-Genswein et al., 2016; González et al., 2012b). Mortality rates during transportation have been reported to be greater in feeder cattle than fat or mature cattle. However, mature cattle exhibited the greatest incidence of lameness or becoming non-ambulatory (González et al., 2012b). A study assessing the arrival conditions of mature cattle at a federal abattoir in AB found that 29.4 % of cattle were found to have a serious welfare problem (Goldhawk et al., 2015). They concluded that mature cattle for sale or slaughter have the greatest risk of deterioration during transport (Goldhawk et al., 2015). Currently, there is little information in the scientific literature regarding the effects of cattle type (beef or dairy) on the risk of poor transportation outcomes. However, one study did report that dairy cattle are more likely to have defects (defects included evidence of prolapses, foot abnormalities, and poor udder conditions) than beef cattle (Ahola et al., 2014a; 2014b). Furthermore, the information about seasonality and mud coverage on compromised and unfit cattle is lacking. Looking at seasonality can provide insight about the marketing trends of producers shipping cattle that are compromised or unfit.

The main objectives of the current study were to: 1) determine the relationship between compromised or unfit cattle and their age, cattle type, season and mud coverage and 2) determine

the relationship between conditions associated with transportation fitness including lameness, emaciation, and cattle in heavy lactation, and animal age and type, season, and mud coverage.

## 3.2 Materials and Methods

This observational study investigated the transportation fitness of cattle arriving to auctions and abattoirs within AB. Information on animal condition was collected after cattle were unloaded at their given destination and therefore, care and handling of animals was not supervised or controlled by the research team. Although the study was only observational in nature, approval to conduct the study was still obtained from the Animal Care and Use Committee of the Agriculture and Agri-Food Canada Lethbridge Research Centre according to the guidelines established by the Canadian Council on Animal Care (ACC 1634; National Farm Animal Care Council, 2013).

### 3.2.1 Stratification and Sampling Protocol

As described in Chapter 2, auction and abattoir participants were selected based on their annual sale and slaughter volumes as well as their willingness to participate in the study. The final set of participants included eight auction markets, 11 provincial abattoirs, and one federal abattoir. The auction markets included four low (≥ 65,000 cattle sold annually) and four high volume auctions (< 65,000 cattle sold annually). The provincial abattoirs included four low (slaughtering < 275 cattle annually), three medium (slaughtering 276-543 cattle annually), and four high (slaughtering > 543 cattle annually) volume abattoirs. No stratification was required for federal abattoirs as only one participated in the study and it had an estimated slaughter volume of 1,000,000 head of cattle annually.

During a one year study, site visits were conducted a total of six times per site at auction markets (once every eight weeks) and nine times per site at each provincial and federal abattoir (once every six weeks). During each sampling cycle both researchers visited one auction market and one provincial abattoir together and both researchers were present during all federal abattoir visits to ensure high inter-observer reliability for assessing cattle conditions. During inter-observer site visits, the same cattle were assessed by both observers and agreement between observers was determined after the site visit to identify any inconsistencies in scoring which would be discussed by the research team and additional training would be done if necessary.

Only the scores of the researcher assigned to the site were used in the final data set after inter-observer reliability was evaluated.

At each site visit, a random subset of cattle were assessed within their holding pens prior to sale or slaughter with the exception of provincial abattoirs where all cattle at each abattoir were assessed to meet the required minimum sample size (described in the statistical analysis section). The total number of cattle assessed at each auction and the federal abattoir was determined based on the sale or kill volume occurring that day and random selection of liners or pens would be made during the assessment (e.g. every fifth pen, or every fourth cattle liner). Cattle were not assessed during handling or in assembly for slaughter due to the effects of handling on cattle behaviour and ease of observer assessment. The exception to this was the federal abattoir, as the only chance to clearly observe the cattle was at the time of unloading and or walking to lairage.

Animals assessed at each site were further stratified by age to represent 80 % feeder/fat cattle and 20 % mature cattle which is representative of the distribution of cattle typically seen at central collection points in each population (Alberta Agriculture and Forestry Personal Communication, 2015).

In the main study, auction market sampling (N = 4561 cattle) were based on six site visits to each of the eight selected auction markets within the year observing 20 % of cattle at low sale volume auctions (n = 692 cattle) and 80 % of cattle at high volume auctions (n = 2766 cattle). At each high volume auction market site visit approximately 400 cattle would be assessed, and approximately 100 cattle at each low volume auction market site visit.

Provincial abattoirs (N = 1069 cattle) were based on nine site visits to 11 selected provincial abattoirs within the year observing 10 % of cattle at low slaughter volume abattoirs (n = 346), 20 % of cattle at medium slaughter volume abattoirs (n = 692 cattle), and 70 % of cattle at high slaughter volume abattoirs (n = 2421 cattle). All cattle were assessed at provincial abattoir site visits in order to try and meet the minimum sample size required. Lastly, as there was only one participating federal abattoir nine site visits within the year (N = 4013 cattle). Approximately 400 cattle would be assessed at each federal abattoir site visit.

### 3.2.2 Data collection

The assessment tool developed in Chapter 2 was used to determine if randomly selected cattle are arriving at central collection points were in compromised or unfit condition. Two

trained observers would collect general information on each animal that included the type of facility assessed (auction, provincial or federal abattoir), cattle type (beef or dairy breed), sex (female, steer, or bull), age (neonatal calves (< 28 d of age) with the presence of umbilical cord tissues; feeder, growing or finishing feedlot cattle or yearlings off pasture, or mature; older than finished weight cattle), and a mud score (four point scale (from Mader and Colgan, 2007)). Compromised and unfit cattle were assessed under a variety of categories including: Nutrition, Depression/Attitude, Respiratory Issues, Indicators of Pain, Mobility Issues, Udder Condition, Eye Health Conditions, Injuries and Integuments, Reproductive Health Conditions, and finally Abnormal Behaviour. All cattle were assessed within their pens and were observed for a minimum of 30 seconds per animal to obtain pertinent information and also during ambulation to assess their gait. Ambulation was also observed at unloading or when staff was moving the animals to a holding pen.

### 3.2.3 Data Management and Statistical Analysis

#### 3.2.3.1 Sample Size Determination

A sample size calculation was conducted to determine the minimum number of cattle that needed to be assessed within each population (auctions, provincial and federal abattoirs) and subcategories (low, medium, and high throughput auctions and abattoirs) to ensure statistical power and scientific validity (Browner et al., 2013). The calculation was based on the proportion of cattle being sold or slaughtered annually and the composition of location types within AB. The calculation used an expected prevalence of 10 %, confidence interval of 95 % and a precision of 1 %. This was based on the information obtained from the pretest using provincial abattoir information as described in Chapter 2 where a minimum sample size of 3,458 head of cattle was determined to provide adequate statistical power for each population (auction markets, provincial abattoirs, and the federal abattoir) over the year.

#### 3.2.3.2 Data Management and Analysis

Prior to data analysis, one young (< 28 days of age) animal observed at an auction market was removed from the dataset leaving a total of 4,560 cattle to be used in the auction market analysis and one dual purpose animal observed at a provincial abattoir was removed from the dataset leaving a total of 1,068 cattle to be used in the provincial abattoir analysis. These were removed simply because they were outliers in the logistic regression analysis.

Data analysis was conducted using STATA, version 14.2 (StataCorp, 2015, College Station, TX). A descriptive analysis was performed on all conditions and independent variables. Consequently, based on location type (auction market cattle, provincial and federal abattoir cattle) the animal was the experimental unit. The descriptive analysis was also used to document location type level and individual animal-level characteristics.

Five independent variables (age, cattle type, sex, mud, and season) were tested using a multilevel-mixed logistic regression model. To simplify statistical analysis, several conditions were dichotomized as shown in Table 3-1. Multiple logistic regression was performed using the generalized linear mixed model (GLMM) procedure in STATA (StataCorp, 2015, College Station, TX, USA) and a P-value $\leq 0.05$ was considered significant. STATA was used to assess effect modification and confounding variables that had elevated odds ratios during univariate analysis. Building a model involved several steps. Univariable analyses were performed to assess associations between the outcome of interest (cattle being "fit" or "compromised or unfit", or cattle with specific compromised or unfit conditions that included "lame", "emaciated", or "in heavy lactation"), and each independent variable. Independent variables identified with a univariate association ($P \leq 0.20$) were considered for the next step of multivariate modeling with the following independent variables: cattle age (feeder/fat or mature), cattle type (dairy or beef), sex (female, steer, or bull), mud (mud below the knees, or mud above knees covering belly and sides) and season (winter, summer, and fall). The referents of each independent variable were: feeder/fat for age, beef for cattle type, female for sex, mud below the knees for mud, and winter for season. Age was included as a variable in every statistical analysis to account for the population distribution of cattle in AB. Referents were chosen based on the most frequent category collected in each variable.

Location type (auction market, provincial abattoir, or federal abattoir) was included as a random effect and each model was completed separately for each location type. Independent variables were assessed for collinearity using a Spearman rank correlation coefficient where a $P \geq 0.7$ indicated the presence of collinearity. If collinearity was present, separate models were reconsidered for the correlated variables and the model with the lowest Akaike Information Criterion (AIC) was selected (Dohoo et al., 2014). The next step involved screening of the five-predictor variables in separate multilevel-mixed logistic regression models. After univariate analysis was performed on each variable, significant variables were included in the multivariable

analysis and a backwards elimination was performed. If any confounding variables (variable that resulted in a > 20 % change in the estimate of any significant predictor) were present, then that variable was kept in the final model. Variables significant at $P \leq 0.05$ were retained for the final model. Assessments for interaction were tested among the significant predictor variables in the main effects model and were confirmed by significant Likelihood-ratio tests where a P-value $\geq$ 0.05 indicated no significant interaction present and a P-value $\leq 0.05$ confirmed an interaction effect (Dohoo et al., 2014). To assess the final model's goodness of fit, residuals were plotted on a nonparametric Receiver Operating Characteristic (ROC) curve, which measured the Area Under the Curve (AUC). An AUC value of $\geq 0.5$ was assessed further by comparing the Inter Class Correlations (ICC) between the null model and the final model. This was used to determine the percentage of variance between the models and if there were any protective effects present.

## 3.3 Results

### 3.3.1 Factors Associated with Cattle Arriving at Auction Markets Compromised and Unfit

The odds of an animal being compromised or unfit on arrival to an auction market was 23.3 times greater for mature cattle than feeder or fat cattle (95 % confidence interval [CI] = 13.8 to 39.3; $P < 0.01$;Table 3-2). Furthermore, the odds of a mature animal arriving emaciated to an auction market were 6.3 times greater than for feeder or fat cattle (95 % CI = 3.1 to 12.8; $P < 0.01$; Table 3-3). Mature cattle had 14.2 (95 % CI= 4.3 to 46.9; $p < 0.01$) times greater odds of arriving at an auction lame than feeder or fat cattle (Tables 3-7 and 3-8).

Dairy cattle were 7.5 times more likely (95 % CI = 5.3 to 10.6; $P < 0.01$) to arrive at an auction market in a compromised or unfit condition than beef cattle (Table 3-2). Furthermore, Table 3-3 shows that dairy cattle had 5.8 greater odds (95 % CI=3.5 to 9.8; $P < 0.01$) of arriving emaciated than beef cattle. Cattle arriving to auction markets with a mobility score $\geq 3$ were 2.9 more likely to be dairy than beef cattle (95 % CI = 1.4 to 6.1; $P < 0.01$; Table 3-5).

There was a cattle type × season interaction for cattle arriving in heavy lactation to auction markets. During the summer and fall months dairy cattle were 11.6 (95 % CI = 2.8 to 48.8; $P < 0.01$) and 4.4 times (95 % CI = 0.03 to 16.3; $P = 0.03$) more likely to arrive at auction markets in heavy lactation than beef cattle in winter months, respectively (Table 3-4).

Bulls had 4.7 times greater odds of arriving to an auction lame than female cattle (95 % CI = 2.4 to 9.2; P < 0.01; Table 3-5). Females were at 8.3 times greater odds of arriving emaciated than steers (95 % CI = 0.02 to 0.9; P = 0.04; Table 3-3). Lame cattle arriving to auctions had a 4.5 times greater odds of having mud on their hide above their knees or higher (95 % CI = 2.3 to 8.8; P < 0.01; Table 3-5).

### 3.3.2 Factors Associated with Cattle Arriving at Provincial Abattoirs Compromised and Unfit

Mature cattle had 2.8 greater odds of arriving to a provincial abattoir in a compromised or unfit condition than feeder or fat cattle (95 % CI = 1.7 to 4.5; P < 0.01; Table 3-6). Furthermore, mature cattle were 29.5 times more likely to arrive in an emaciated condition than feeder or fat cattle (95 % CI = 6.1 to 143; P < 0.01; Table 3-7). As shown in Table 3-8 mature cattle were 2.0 times more likely to be lame on arrival in comparison to feeder or fat cattle (95 % CI = 1.2 to 3.5; P = 0.01).

Dairy cattle were 2.7 times more likely (95 % CI = 1.4 to 5.1; P < 0.01) to arrive in a compromised or unfit condition than beef cattle (Table 3-6) and also had 14.7 greater odds of arriving in an emaciated condition than beef cattle (95 % CI = 3.9 to 54.8; P < 0.01; Table 3-7). Lame cattle were found to have 2.6 greater odds of being dairy than beef cattle (95 % CI = 1.3 to 3.5; P = 0.01; Table 3-8).

Cattle were more likely to arrive to provincial abattoirs in a compromised or unfit condition in summer (2.0 greater odds; 95 % CI = 1.3 to 3.0; P < 0.01) and fall (1.8 greater odds; 95 % CI = 1.1 to 2.7; P = 0.01) months than winter (Table 3-6). The odds of cattle arriving lame were 2.0 times greater in summer (95% CI = 1.2 to 3.2; P < 0.01) and fall (95 % CI = 1.2 to 3.2; P < 0.01) than in winter months (Table 3-8).

### 3.3.3 Factors Associated with Cattle Arriving at a Federal Abattoir Compromised and Unfit

The odds of an animal being compromised or unfit on arrival to a federal abattoir was 1.7 times greater for mature cattle than feeder or fat cattle (95 % CI = 1.1 to 2.7; P = 0.02; Table 3-9). As shown in Table 3-10, there was no effect of age on lame cattle upon arrival (95 % CI = 0.9 to 2.7; P = 0.13).

The only condition that was found to be statistically significant in the compromised or unfit cattle arriving to the federal abattoir was lameness. The odds of an animal being lame on arrival was 5.2 times greater for cattle that had mud covering their hide above their knees than those with mud covering below their knees (P = 0.03; Table 3-10).

## 3.4 Discussion

### 3.4.1 Risk Factors for Compromised and Unfit Conditions

Mature cattle were at the greatest risk of arriving at auction markets and provincial and federal abattoirs in a compromised or unfit condition. It has been reported that the probability of cattle becoming injured or dying drastically increases with the age of the animal (Greer et al., 1980). Mature cattle are most likely culled from the herd due to old age or poor health, which can be associated with extreme weight loss that reduces their energy reserves (Waldner et al., 2009).

Ahola et al. (2014a) reported that dairy cattle had more health concerns or defects than beef cattle. Dairy cattle have been shown to have lower energy reserves and have a more intensive production system than beef cattle (Oltenacu and Algers, 2005). Also, compromised and unfit cattle had greater odds of arriving in the summer and fall months. This may be related to the fact that peak times for culling occur in summer and fall, particularly for beef cattle (Waldner et al., 2009). If a beef cow or heifer has not produced a calf or had reproductive issues such as poor udder condition or prolapses they would usually be culled from the herd during the summer (Waldner et al., 2009). Furthermore, in the fall during pregnancy verification, a cow that is open or appears to be compromised (lameness, cancer eye, or poor udder condition) is typically culled from the herd (Pinedo et al., 2010; Waldner et al., 2009).

According to the CFIA regulations, it is unacceptable to transport an unfit animal for any other reason than for veterinary care, as transportation would result in undue and unjustified suffering of the animal (Canadian Food Inspection Agency, 2013a). Compromised cattle that arrived at the provincial abattoirs were being managed properly according to the CFIA definition, which states that they may be “transported locally for slaughter, to be euthanized, or receive care by a veterinarian” (Canadian Food Inspection Agency, 2013a). Locally refers to the closest available abattoir for slaughter that can provide producers a humane way of culling compromised or poor doing cattle from their herd or feedlot before the animals’ condition

becomes so severe that they are considered unfit. It is important to acknowledge that compromised cattle may be transported under appropriate circumstances. Therefore, the transportation of compromised cattle is less concerning because the transportation of compromised cattle should not cause undue suffering to the animal. Whereas, the transportation of unfit cattle would result in unjustified suffering and pain to the animal.

### 3.4.2 Emaciation

Mature cattle and dairy cattle had greater odds of arriving at auctions and provincial abattoirs emaciated than feeder/fat cattle. Also, female cattle arriving to auctions had greater odds of arriving in an emaciated condition than steers. Although no interaction was present, the majority of mature and dairy cattle observed at auctions were female. A US study reported that the mean BCS for mature beef cows and bulls arriving at auctions ranged between 4.7 and 5.3 (on a nine-point scale), while mature dairy cows and bulls ranged between 2.6 to 2.9 (on a five-point scale) (Ahola et al., 2014a). These finding suggest that mature dairy cattle have a lower average body condition than mature beef cattle, which is also in agreement with a recent Canadian study indicating the prevalence of emaciation (BCS less than or equal to 1.5) to be 1.70 % in mature cattle arriving to federal abattoirs (Goldhawk et al., 2015). This suggests that mature cattle are most likely culled from the herd due to old age or poor health, which can be associated with extreme weight loss and low energy reserves that result in weakness (Waldner et al., 2009). It is recommended that cattle must be culled prior to becoming emaciated to ensure good welfare outcomes, as emaciated cattle may not be strong enough to withstand transport (Grandin, 2001).

### 3.4.3 Lactation

In the current study, cattle at greatest risk of being transported to auctions in heavy lactation were dairy cattle. Goldhawk et al. (2015) documented that 10 out of 12 loads of cattle had mature cows with poor or torn udder conditions however, they did not assess if the cattle were lactating. Dairy cattle had greater odds of arriving to auction markets in heavy lactation than beef cattle in winter months. As dairy cattle produce milk year round, producers may be less likely to keep their poor doing cattle, as all cattle are required to be in a barn during the winter. No mature dairy cattle were observed at the federal abattoir because the plant did not purchase any for slaughter, and mature dairy cattle are typically shipped into the US for slaughter (N.

Simmons Personal Communication, 2017). There is currently a lack of studies documenting cattle arriving to central collection points in heavy lactation.

### 3.4.4 Lameness

Lameness in dairy cattle is well documented as a major health and serious welfare problem (Von Keyserlingk et al., 2009; Hemsworth et al., 1995). In the current study dairy cattle were at greater odds of arriving lame to auction markets and abattoirs, and mature cattle had greater odds of arriving lame to all central collection point types. A Canadian study assessing 19 slaughter facilities reported that 90 % of non-ambulatory cattle were dairy breeds, and the remaining 10 % were beef breeds (Stull et al., 2007). The same study also reported the incidence of non-ambulatory cattle to be between 0.7% and 1.1% in beef cattle and between 1.1% and 1.5% in dairy cattle (Stull et al., 2007).

In the present study, bulls had greater odds of arriving lame to auction markets than female cattle. Female cattle are culled for a variety of reasons that may include calf production and reproductive health (Waldner et al., 2009), while bulls are often culled for lameness as it greatly affects their breeding performance (McDiarmid, 1981). Also, cattle arriving lame to auction markets and the federal abattoir had greater odds of having mud up above their knees than below their knees. Cattle with poor hygiene or in muddy pens have been reported to have greater instances of lameness associated with infectious bacteria such as footrot or digital dermatitis (Cook, 2002).

### 3.4.5 Age

All three location types assessed had a greater prevalence of mature cattle arriving in compromised and unfit conditions compared to fat and feeder cattle. These findings are expected because mature cows are typically culled due to reduced health or reproductive performance causing them to be economically nonviable (Schwartzkopf-Genswein et al., 2016). Mature cattle are at a greater risk of poor welfare because of their naturally low economic value, which may result in reduced care (Goldhawk et al., 2015). The findings of the present study are also in agreement with a recent Canadian study that reported at least half of the loads (6 out of 12) of mature beef cattle arriving to a federal abattoir contained one compromised cow at the time of unloading (Goldhawk et al., 2015). The transportation of mature cattle has been identified as a serious animal welfare issue because mature cows are, by nature one of the most fragile types of

animals transported which results in greater mortality rates post transportation than feeder/fat cattle (Schwartzkopf-Genswein et al., 2012; Schwartzkopf-Genswein et al., 2016).

### 3.4.6 Cattle Type

Dairy cattle were at greater odds of arriving compromised or unfit to auctions and provincial abattoirs than beef cattle. This is most likely related to the fact that they are often thin with marginal energy reserves after being on a lactation rotation and are also culled for a variety of reasons including lameness, low body condition, udder and reproductive health concerns (Roche et al., 2009). Dairy cattle have been selected for increased milk yield that ultimately decreases their longevity and ability to cope with metabolic stress (Oltenacu and Algers, 2005). Increasing milk yield results in an increasing profit for producers, but as a trade off for decreasing animal welfare by consumers (Oltenacu and Algers, 2005). Dairy cattle are arriving at auctions and provincial abattoirs compromised and unfit, but dairy cattle were rarely observed at the federal plant. This suggests that dairy cattle are being transported elsewhere for slaughter in larger volumes (N. Simmons Personal Communication, 2017).

There was no effect of cattle type observed in the federal abattoir due to the fact that no mature dairy cattle were observed at the federal abattoir, and very minimal feeder/fat aged dairy cattle were observed during assessment. This also suggests that mature dairy cattle are being transported elsewhere for slaughter.

### 3.4.7 Study Limitations and Future Implications

This study is the first to document the risk factors associated with compromised and unfit conditions occurring in AB auction markets and abattoirs. It provides scientific evidence of animal-level risk factors associated with compromised and unfit conditions and consequently some insight for where producer education is required to properly manage compromised and unfit cattle. It is important to consider the age and type of cattle when making loading decisions.

Although loading conditions prior to transport were not recorded in this study, they could provide valuable information about the effects of transport on the outcomes of cattle arriving to their destination in a compromised or unfit condition. Studies investigating the relationship between animal condition and carcass quality and yield would be useful in determining whether these cattle actually have economic value for the processor and or producer. This may show the prevalence of condemnation or deductions that may arise from shipping certain compromised or

unfit cattle that would be okay to transport or should be euthanized on farm. Driver experience would be an interesting factor to examine, however that information could not be collected during this study.

Overall the prevalence of compromised and unfit cattle arriving to auction and abattoirs was low (ranging from 0.1 % to 4.3 % in all location types) suggesting that the industry is managing the problem appropriately. However, 18.0 % of cattle were arriving at provincial abattoirs in a compromised condition, but this is to be expected as compromised cattle may be transported locally for humane slaughter. Further reducing this prevalence will entail providing industry stakeholders with simple and clear assessment methods and disposal alternatives.

**Table 3-1.** Dichotomized scoring systems for statistical analysis.

| Score | Dichotomy | |
|---|---|---|
| | **Yes** | **No** |
| Mud Scale | Mud Score < 2 | Mud Score ≥ 3 |
| Compromised Cattle Scale | Compromised or Unfit | Fit |
| Emaciation | BCS ≤ 1.5 | BCS > 2 |
| Lameness | Mobility Score ≥ 3 | Mobility Score < 2 |

**Table 3-2.** Factors associated with the risk of observed cattle being classified as compromised or unfit (n = 212) at eight Alberta auction markets.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Cattle Type**[a] | | | | |
| Beef | 134 | Referent | | |
| Dairy | 78 | 7.47 | 5.27 to 10.6 | <0.01 |
| **Age** | | | | |
| Feeder/Fat | 16 | Referent | | |
| Mature | 196 | 23.3 | 13.8 to 39.3 | <0.01 |

[a] Cattle type does not add up to 4560 due to uncollected data.

**Table 3-3.** Factors associated with the risk of observed cattle being classified as emaciated (n = 75) at eight Alberta auction markets.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Cattle Type**[a] | | | | |
| Beef | 47 | Referent | | |
| Dairy | 28 | 5.84 | 3.46 to 9.85 | <0.01 |
| **Age** | | | | |
| Feeder/Fat | 11 | Referent | | |
| Mature | 64 | 6.34 | 3.14 to 12.8 | <0.01 |
| **Sex** | | | | |
| Female | 74 | Referent | | |
| Steer | 1 | 0.12 | 0.02 to 0.91 | 0.04 |
| Bull | 0 | Empty | | |

[a] Cattle type does not add up to 4560 due to uncollected data.

**Table 3-4.** Factors associated with the risk of observed cattle being classified as being in heavy lactation[a] (n = 95) at eight Alberta auction markets.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Cattle Type** | | | | |
| Beef | 38 | Referent | | |
| Dairy | 57 | 10.4 | 4.73 to 23.0 | <0.01 |
| **Season** | | | | |
| Winter | 52 | Referent | | |
| Summer | 24 | 0.07 | 0.02 to 0.24 | <0.01 |
| Fall | 19 | 0.19 | 0.07 to 0.51 | <0.01 |
| **Season x CattleType** | | | | |
| Winter × Beef | 30 | Referent | | |
| Winter × Dairy | 22 | N/A | | |
| Summer × Beef | 3 | N/A | | |
| Summer × Dairy | 21 | 11.6 | 2.77 to 48.8 | <0.01 |
| Fall × Beef | 5 | N/A | | |
| Fall × Dairy | 14 | 4.35 | 0.03 to 16.3 | 0.03 |

[a] Only observed in females.

**Table 3-5.** Factors associated with the risk of observed cattle being classified as lame (n = 46) at eight Alberta auction markets.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Cattle Type** | | | | |
| Beef | 34 | Referent | | |
| Dairy | 12 | 2.92 | 1.40 to 6.07 | <0.01 |
| **Age** | | | | |
| Feeder/Fat | 3 | Referent | | |
| Mature | 43 | 14.2 | 4.30 to 46.9 | <0.01 |
| **Sex** | | | | |
| Female | 30 | Referent | | |
| Steer | 0 | Empty | | |
| Bull | 16 | 4.69 | 2.40 to 9.17 | <0.01 |
| **Mud** | | | | |
| Mud below knees | 12 | Referent | | |
| Mud above knees | 34 | 4.48 | 2.28 to 8.81 | <0.01 |

**Table 3-6.** Factors associated with the risk of observed cattle being classified as compromised or unfit (n = 219) at 11 Alberta provincial abattoirs.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Cattle Type** | | | | |
| Beef | 197 | Referent | | |
| Dairy | 22 | 2.65 | 1.38 to 5.12 | <0.01 |
| **Age** | | | | |
| Feeder/Fat | 173 | Referent | | |
| Mature | 46 | 2.77 | 1.72 to 4.46 | <0.01 |
| **Season** | | | | |
| Winter | 62 | Referent | | |
| Summer | 83 | 2.00 | 1.32 to 3.03 | <0.01 |
| Fall | 74 | 1.76 | 1.14 to 2.72 | 0.01 |

**Table 3-7.** Factors associated with the risk of observed cattle being classified as emaciated (n = 11) at 11 Alberta provincial abattoirs.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Cattle Type** | | | | |
| Beef | 6 | Referent | | |
| Dairy | 5 | 14.7 | 3.93 to 54.8 | <0.01 |
| **Age** | | | | |
| Feeder/Fat | 2 | Referent | | |
| Mature | 9 | 29.5 | 6.07 to 143 | <0.01 |

**Table 3-8.** Factors associated with the risk of observed cattle being classified as lame (n = 162) at participating Alberta provincial abattoirs.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Cattle Type** | | | | |
| Beef | 145 | Referent | | |
| Dairy | 17 | 2.60 | 1.29 to 5.22 | 0.01 |
| **Age** | | | | |
| Feeder/Fat | 131 | Referent | | |
| Mature | 31 | 2.03 | 1.19 to 3.48 | 0.01 |
| **Season** | | | | |
| Winter | 44 | Referent | | |
| Summer | 60 | 1.98 | 1.24 to 3.16 | <0.01 |
| Fall | 58 | 1.98 | 1.23 to 3.19 | <0.01 |

**Table 3-9.** Factors associated with the risk of observed cattle being classified as compromised or unfit (n = 78) at one Alberta federal abattoir.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Age** | | | | |
| Fat | 47 | Referent | | |
| Mature | 31 | 1.70 | 1.07 to 2.70 | 0.02 |

**Table 3-10.** Factors associated with the risk of observed cattle being classified as lame (n = 61) at one Alberta federal abattoir.

| Predictor Variable | n | Odds Ratio | 95% CI | p-value |
|---|---|---|---|---|
| **Age** | | | | |
| Fat | 42 | Referent | | |
| Mature | 19 | 1.54 | 0.88 to 2.70 | 0.13 |
| **Mud** | | | | |
| Mud below knees | 2 | Referent | | |
| Mud above knees | 59 | 5.22 | 1.23 to 22.0 | 0.03 |

# CHAPTER 4: GENERAL DISCUSSION AND FUTURE RESEARCH

## 4.1 Conclusions

After a thorough review of the scientific literature and discussions with CFIA inspectors, veterinarians, and other industry stakeholders it was evident that there is no standard set of criteria for what constitutes a compromised or unfit animal. An important first step in improving the ability to assess fitness for transport is first documenting the scope of the problem. In addition, understanding what conditions are most prevalent and how best to evaluate their overall impact on animal fitness as well as understanding what risk factors contribute to poor welfare outcomes is critical. The ultimate goal is to reduce animal suffering while maintaining industry commerce, carcass salvage value and consumer confidence.

Chapter 1 introduced CFIA's definitions and current conditions of compromised and unfit cattle. Compromised cattle are defined by CFIA as "*cattle that may be locally transported with special provisions to receive care, be euthanized or humanely slaughtered*" (Canadian Food Inspection Agency, 2013a). Unfit cattle are defined by CFIA as "*an animal with reduced capacity to withstand transportation and where there is a high risk that transportation will lead to undue suffering. Unfit animals if transported would endure unjustified and unreasonable suffering. Unfit animals may only be transported for veterinary treatment or diagnosis*" (Canadian Food Inspection Agency, 2013a). Proactive prevention measures must be taken to avoid negative public perception of the cattle industry due to transporting compromised and unfit cattle to central collection points. In order to reduce the number of these types of animals being transported, all industry stakeholders need to have a simple and effective set of guidelines for identifying cattle that should never be shipped or that should only be shipped with special provisions. These guidelines should also identify animal or environmental factors that place cattle at higher risk of poor welfare outcomes during or post transport.

Chapter 2 described the methodology used to develop a new assessment tool to evaluate compromised and unfit conditions in cattle. The limitations in the fitness for transport criteria developed by CFIA were discussed. The main limitations included the use of strictly visual criteria that cannot be confirmed in a field setting or by non-veterinary evaluators. For this reason, a new tool was developed to provide all industry stakeholders with a descriptive visual way of assessing cattle for transportation fitness. The new assessment tool was used in a three-month pilot study at central collection points in AB to determine the functionality of the newly

added scoring systems and assessment methods. The inter-rater reliably (IRR) between two observers assessing the same cattle was an important aspect of the study as it helped to confirm that the new tool (and scoring systems) was simple to follow and repeatable over time. From these results, there were many important findings about what compromised and unfit conditions were and how they could be properly assessed in the field by two non-veterinarians experienced in assessing illness in cattle. The IRR analysis provided evidence that the scoring systems used were relatively repeatable showing good agreement ($r > 0.85$) between observers and confidence that the new tool could be used in the main study described in Chapter 3. Furthermore, Chapter 2 described the prevalence of compromised cattle arriving at auction markets, provincial and federal abattoirs in AB using the new assessment tool to determine fitness for transportation. The data was collected over a one-year period at 20 central collection points comprised of eight auction markets, 11 provincial abattoirs, and one federal abattoir. From these results there were many important epidemiological findings based on location type. For example, there was evidence of compromised and unfit cattle still arriving at auction markets and unfit cattle still arriving at auctions and abattoirs. Auctions and provincial abattoirs had the highest prevalence of emaciation (1.2 %), whereas federal abattoirs had an emaciation prevalence of < 1 %. Furthermore, female cattle had greater odds of arriving to auctions emaciated. Auctions had the greatest prevalence of cattle arriving in heavy lactation (7.9 %) in comparison to provincial (2.9 %) and federal (0.0 %) abattoirs. Provincial abattoirs had the largest reported prevalence of lameness in cattle upon arrival (15.3 %) than the federal abattoir (1.5 %) and auctions (< 1 %). Severe injuries had the greatest reported prevalence in provincial abattoirs (8.2 %), whereas the reported prevalence at auctions and the federal abattoir was < 1 %. Provincial abattoirs had the largest prevalence of weak cattle arriving (1.4 %), whereas auctions and the federal abattoir had a prevalence of < 1 %.

Compromised and unfit cattle are still arriving at auctions and the federal abattoir, when compromised cattle should be transported locally for slaughter at a provincial abattoir, or euthanized with or without salvage of the carcass. Of the compromised cattle arriving at auctions < 1 % where sent to a local abattoir for humane slaughter, and the remainder of the compromised cattle continued to be sold in the sale. Of the unfit cattle arriving to auctions, none of the unfit cattle were euthanized on site. The majority of unfit cattle arriving at auction markets still continued on for regular sale, while two other instances reported unfit cattle were returned to the

original consignor or sent home prior to unloading. Of the compromised cattle arriving at the federal abattoir, all of the cattle continued on for regular slaughter. Of the unfit cattle that arrived at the federal abattoir, half of them were euthanized on the loading dock after unloading or in the holding pen after clearing the rest of the pen while the other half were slaughtered. Provincial abattoirs saw the greatest prevalence of cattle arriving in compromised and unfit conditions. It is important to acknowledge that compromised cattle should be arriving to provincial abattoirs for slaughter, therefore it is no surprise that all of the compromised cattle continued on for regular slaughter. However, the majority of unfit cattle arriving at provincial abattoirs continued on for regular slaughter, 9.0 % were salvaged in their holding pens at the slaughter facility, and 3.4 % were euthanized in the holding pen without salvage of the carcass due to the circumstances of the animal's condition. Unfit cattle should be euthanized and bled on farm, and the carcass be transported to be salvaged at a provincial abattoir.

In Chapter 3, the association between animal level risk factors including age, cattle type, sex, seasonality, and mud fitness for travel ("fit", "compromised", and "unfit") was determined. Cattle arriving in an emaciated condition to auctions and provincial abattoirs were more likely to be mature cattle than feeder/fat cattle, and more likely to be dairy cattle than beef cattle. An interaction was observed between dairy cattle arriving in the summer and dairy cattle arriving in the fall compared to beef cattle arriving in the winter. Dairy cattle were at greater odds of arriving to auctions in heavy lactation than beef cattle. Furthermore, cattle arriving in heavy lactation were at greater odds of arriving in winter months than fall and summer months. Cattle arriving lame to auctions and provincial abattoirs were more likely to be mature cattle and dairy cattle. Lameness was more likely in bulls arriving to auctions and lame cattle arriving to auctions and the federal abattoir were more likely to have a higher mud score. Furthermore there was an effect of seasonality that showed greater odds of cattle arriving to provincial abattoirs lame during summer and fall than winter months.

Mature and dairy cattle were found to be at greatest risk of arriving in compromised and unfit conditions to auction markets and abattoirs. Furthermore, summer and winter months increased the risk of compromised cattle arriving to provincial abattoirs. Lastly, mature cattle were at the greatest risk of arriving in a compromised or unfit condition at the federal abattoir.

This study confirms several animal level factors that contribute to the risk of cattle arriving in a compromised or unfit condition at auctions and abattoirs. Age, cattle type, and

seasonality have all been implicated as risk factors for cattle arriving to central collection points in an unfit or compromised condition. Further analysis of transport level factors (distance travelled, trailer type, and group size) and the role of economics will be examined in another study. The animal level factors found to impact cattle fitness in this study support the anecdotal reports of auction market and abattoir owners. Compromised and unfit conditions should be dealt with in the same way for both dairy and beef industries when implementing educational information about which cattle are fit for transport for the purposes of slaughter and which cattle should be euthanized on farm for salvage slaughter. While farm sizes increase, producers are more likely to properly manage the marketing endpoints of cattle that are doing poorly. Furthermore, the role of discouraging producers from shipping compromised or unfit cattle to auction markets must be enforced correctly by inspectors or other agencies to avoid auction owners from losing business if they reject cattle arriving in unfit condition only to be transported to another auction that will accept the cattle. Communication amongst inspectors, producers, processors, and auction and abattoir owners must take place in the cattle industry to better understand what conditions are considered compromised or unfit for transportation.

Project limitations include the inability to investigate post mortem evaluations after slaughter. There appears to be a significant reduction in carcass quality and yield in unfit cattle in comparison to compromised cattle conditions that may inhibit the carcass from being fit for human consumption and condemned at slaughter. Another major limitation in Chapter 3 was the inability to observe enough animals (as determined in the calculation of the minimum required sample size) at provincial abattoirs, which may have resulted in the misrepresentation the number of compromised and unfit cattle arriving to those locations. Furthermore, the lack of observations of compromised and unfit cattle at federal abattoirs may also constrain the results of conditions observed based on the volume of cattle that are slaughtered annually at the federal abattoir.

### 4.2 Future Research

Future work that evaluates the condition of cattle prior to transportation from their origin to auction markets and abattoirs would be beneficial to understand the effects of transport on cattle. Future work should include developing video or ante mortem assessment methods for animals arriving to provincial abattoirs as shoot and bleeds. This will also help assist in quantifying how many cattle are actually being accepted at the abattoir with the option of being

able to humanely euthanize the animal on farm. This would also help producers better understand, which unfit conditions should be euthanized on farm, but still have salvage value. In addition, future studies should also evaluate cattle condition before and after transport to help determine which conditions are most affected by transport and more specifically by the length and quality of the transport. This would entail following cattle through to their final destination at feedlots or slaughter to determine the deterioration of their conditions and animal level risk factors associated with worsening conditions. With mature cattle in particular, there have been substantiated reports of this cattle type observed at auction markets between one and eight weeks before they are transported to a federal facility for slaughter. These animals would then be followed throughout their stay at an auction market to evaluate the progression of their condition until slaughter and then followed through subsequent transportations post sale. Carcass quality and carcass yield information would also be essential in determining economic factors associated with specific conditions at the time of slaughter.

### 4.3 Implications

The research provided in this thesis has significant and practical implications for the Canadian cattle industry and it stakeholders. Although cattle are still arriving to central collection points in compromised and unfit conditions, the cattle industry is doing reasonable job managing these cattle as evidenced by the relatively low prevalence of compromised and unfit cattle upon arrival (ranging from 0.1 % to 4.3 %). However, 18.0 % of cattle were arriving at provincial abattoirs in a compromised condition, but this is to be expected as compromised cattle may be transported locally for humane slaughter. Most importantly, this work has provided scientific evidence that producers and stock attendants can be easily trained to recognise and distinguish the difference between compromised and unfit cattle. Furthermore, this assessment tool could aid people who market cattle make correct loading decisions, which would ultimately allow for the proper culling strategies of compromised and unfit cattle. Lastly, this project has identified animal level risk factors for compromised and unfit cattle. These animal level factors can be used in the prevention of marketing high-risk cattle. Furthermore, knowledge of which sex and age related conditions (e.g. cattle in heavy lactation, penis injuries, and prolapses), put cattle at greatest risk of deteriorating during transport or while in lairage for sale or slaughter is useful for educating producers. Ultimately the goal is to eliminate the causes of undue suffering in cattle

during transportation. Further policing and surveillance of compromised and unfit conditions must continue by all industry partners. Ultimately, minimizing the transport of unfit cattle will only be achieved through improving the ability of all industry stakeholders to easily differentiate between cattle that are fit, compromised or unfit and improving culling strategy alternatives.

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***Appendix A.*** Comparison of compromised conditions recorded in this study compared to Canadian Food Inspection Agency's *Compromised Cattle Policy*.

| Category | Compromised Conditions with New Assessment Tool | CFIA's Animal Policy of Compromised[2] Cattle |
|---|---|---|
| **Respiratory Signs** | • Depression/Attitude Score ≥2 on the five-point system (Dewell, 2013)<br>• Respiratory Score =3 or 4 on the five-point system (Dewell, 2013)<br>• Record signs of respiratory distress including open mouth breathing, wheezing, elbow abduction, neck stretched out, etc.<br>• Exudate from nose and/or mouth | • Laboured breathing |
| **Mobility Signs** | • Lameness Score =3 or 4 (North American Meat Insitute, 2016)<br>• Record signs of abnormal movement (ataxia, non-weight bearing, stiffness, muscle atrophy, missing limb(s) or feet, etc.) | • Lame[3]<br>• Amputee or deformity[4]<br>• Hobbled to prevent kicking |

[2] Compromised animals are animals with reduced capacity to withstand transportation but where transportation will not lead to undue suffering. Compromised animals may be locally transported with special provisions to receive care, be euthanized or humanely slaughtered.
[3] The animal has imperfect locomotion, slight limp; lame leg not immediately identifiable.
[4] In rare instances, were an animal has a deformity or has an amputated limb that has fully healed, and the animal is not suffering due to lameness, it can be transported to local slaughter or care with special provisions, as the deformity or healed amputated limb would render the animal compromised.

| | | |
|---|---|---|
| **Metabolic Issues** | • BCS= 1.5 on the five-point system (with the use of half scores) (Kellog, 2017)<br>• Bloat | • Bloated (if not weak or already down) |
| **Eye Health** | • Blindness in both eyes and behaviour consistent with blindness<br>• Ocular mass without emaciation<br>• Record all lumps and masses (location, size, discharge, and characteristics of impaired eye health) | • Blindness in both eyes<br>• OSCC, Stage 2 or 3 |
| **Integuments and Injuries** | • Record open bleeding wounds (location, size and if there is interference of normal function)<br>• Record broken Horns (describe the severity of bleeding)<br>• Record bone fractures with the presence of the bone breaking through the skin<br>• Record all lumps and masses (location, size, discharge, characteristics and interference with normal function)<br>• Record animals that appear not | • Open wounds or laceration[5]<br>• Has not fully healed after an operation[6]<br>• Acute frostbite |

[5] Depending on the severity of the wound, the animal may be unfit.
[6] Operations such as dehorning or castration.

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| | healed after operation or procedure (describe location and other information) | |
| **Reproductive Conditions** | • Vaginal or rectal prolapse<br>• Recently Calved<br>• Penis injuries<br>• In heavy lactation | • Vaginal or rectal prolapse<br>• Has given birth in preceding 48 hours<br>• Acute or unhealed penis injury<br>• In heavy lactation[7] |
| **Indicators of Pain, Behaviour, and Other Conditions** | • Record visible indicators of pain (yes/no) (e.g. belly kicking, shifting weight, foot stamping, grinding teeth, excessive tail swishing, vocalization and whole body shaking)<br>• Buller Syndrome<br>• Continuous shaking movement<br>• Hernias that do not impede movement | |

[7] Animals in heavy lactation requiring milking every 12 hours, or they will become unfit for transport.

***Appendix B.*** Unfit conditions recorded in study compared to CFIA's Compromised Cattle Policy.

| Category | Items to Describe | CFIA Compromised Animal Policy of Unfit[8] Animals |
|---|---|---|
| **Respiratory Signs** | • Depression/Attitude Score >3 on the five-point system (Dewell, 2013)<br>• Respiratory Score =5 on the five-point system (Dewell, 2013) | • Has a fever |
| **Mobility Signs** | • Lameness Score =4 + instability, or =5 (North American Meat Insitute, 2016)<br>• Non-ambulatory cattle<br>• Split or hobbled cattle | • Lame<br>• The animal is unable to stand without assistance or to move without being dragged or carried (non-ambulatory)[9]<br>• The animal, after splitting, cannot walk, or suffers severe pain when walking, or requires hobbles to stand or prevent further injury[7]<br>• The animal cannot rise without assistance and is reluctant to walk, and exhibits |

[8] Unfit animals are animals with a reduced capacity to withstand transportation and where there is a high risk that transportation will lead to undue suffering.
[9] Meets the definition of non-ambulatory: It cannot rise without assistance and is reluctant to walk, and exhibits halter movement, or it is unable to rise or to remain standing without assistance. Treatment, euthanasia or emergency on-farm slaughter is necessary.

| | | |
|---|---|---|
| | | halted movement[7]<br>• Cannot be transported without undue suffering because of lameness[10]<br>• Has a fractured limb<br>• Has a fracture to the pelvis<br>• Has a rupture of the pre-pubic tendon (splitting)<br>• It has other fractures that considerably hamper mobility or are likely to cause severe pain when the animal is transported |
| **Metabolic Issues** | • Emaciated (BCS <2)<br>• Bloat + Moderate/Severe Respiratory Signs | • Body condition score indicates emaciation and weakness |
| **Eye Health** | • Ocular mass with a BCS <2 | |
| **Integuments and Injuries** | • Severe open bleeding wounds | |
| **Reproductive Conditions** | • Uterine prolapse<br>• Imminently/Recently Calved<br>• If there is a ruptured suspensory ligament | • Uterine prolapse<br>• Likely to give birth |

[10] It cannot be transported without undue suffering because of lameness, even if the animal can rise or remain standing without assistance because the animal demonstrates an obvious limp with uneven weight bearing, and the inability to bear any weight on one leg is immediately identified (unable to use a foot to walk).

| | | |
|---|---|---|
| **Indicators of Pain, Behaviour and Other Conditions** | • Exhaustion/Weak<br>• Hernias that impede movement | • Suffering from dehydration<br>• Suffering from exhaustion<br>• In shock or dying<br>• Has a suspected or confirmed nervous system disorder<br>• Hernias that meet the following: impedes movement (includes conditions in which the hind legs of the animal touches the hernia when the animal is walking), touches the ground when animal is standing in its natural position and/or includes an open skin wound, ulceration or obvious infection |